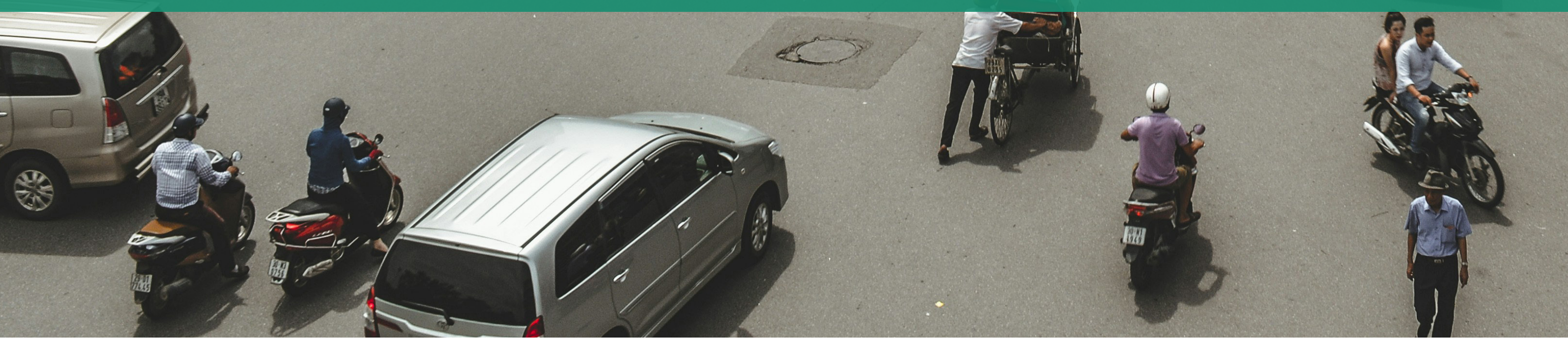
D1.6 IMPACT ASSESSMENT RESULTS

VOLUME 2: HANOI, VIETNAM



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SOLUTIONSplus Impact Assessment Results

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EXECUTIVE SUMMARY

CONTEXT

Vietnam is experiencing rapid economic growth and combined with an increase in urban population growth this results in a rapid increase in transport demand. Both the number of vehicles have sharply increased, as are consequences of this increase in vehicle kms. Keeping up with the challenges brought about by further urbanization, particularly in terms of providing proper transport infrastructure and support services, is becoming a key issue for the country.

HANOI E-MOBILITY FOR LAST-MILE CONNECTIVITY

The demonstration project focusses on boosting the ridership and effectiveness of the currently running BRT and the forthcoming metro rail. The demonstration consisted of a trial with 50 shared e-moped to test the sharing system to facilitate the traveling from BRT stop to a shopping mall and vice versa. Plans are that sharing system will be replicated to other locations in the city, probably connecting the Metro terminal with residential areas. The project's objective was to form the habit of using green traffic modes and raising awareness of environmental protection for people of Hanoi city, application of science and technology in the management and operation of public transport and connection of public transport in the city.

RELEVANT KPI'S

The priorities given to each attribute (KPI) are derived from interactions with the relevant stakeholders, the weighting of the attributes for the Hanoi demonstration occurred in combination with interviews held with stakeholders. By analysing the cumulative weights of indicators, one can observe that effect of society emerged as the main priority of the stakeholders, followed by effect on the environment (2nd), effect on institutional framework (3rd), effect on project finances (4th), effect on wide economy (5th), and effect on climate (6th). It is interesting to notice that the society indicator group had almost twice the weight of the group with the second highest priority (effect on the environment). Another interesting aspect of the results refer to the fact that effect on the environment, such as effect on air pollutants, noise and resource use emerged as the second highest priority group, whereas the effect on climate (GHG emissions) emerged as the last priority group.

SCALE UP

Given the plans to potentially expand the pilot to other locations in Hanoi, we have used a scale up scenario given 50 identical routes to the pilot. In this pilot we have assumed that all routes use the same amount of 50 shared e-mopeds as in the pilot. We have used 275 trips in total (5.5 per moped), which is the break-even point for financial viability. These e-moped trips will replace the shuttle trips, on the basis of passenger kms (pkm). The results of the pilot and the results from the scale up can be found below

HIGH LEVEL KPI	LOWER LEVEL PI	FINDINGS
Project finances	Financial viability	The explorative analysis in the ex-ante assessment focussed on the break-even point as an indicator for **financial viability**. It showed that to break even at the end of the e-moped lifetime 275 daily trips are required per fleet of 50 vehicles. Given the popularity of the route and the large operational time window this should be achievable, given that there is not a more favourable transport option available to travellers.
	Availability of financial resources	Regarding the **availability of financial resources**, it appears that funding can be available for scaled-up e-mopeds project. This conclusion is supported by both public authorities and private sources. The net present value of the scaled-up project is negative. This implies that, purely from a financial perspective, the project isn't self-sustaining and would require external funding. However, given the financial interest coming from public authorities and private parties, as well as the market share that motorcycles have in the transport modes in Vietnam, it is reasonable to expect that there would be financial resources available to make such a scaled-up version of the project possible.
Institutional framework	Coherence with national plans and development goals	For all of these components, the only one in which some uncertainty was experienced was the **alignment with policies and regulations**. The reason for it is that, although multiple examples of policies and legislations related to the e-mopeds project were identified, the available information is not sufficient to fully ascertain whether the proposed project is fully compliant with all relevant legislations. These policies and legislations provide a long-term goal or vision regarding energy, environment or transportation, outlining what is required, what changes will occur, and the timeline for these changes, without necessarily detailing how these regulations or policies will be implemented. Another remark worth noting is that many of the above mentioned policies and legislations do not explicitly refer to electric motorcycles (or similar terms). Instead, they often use broader terms (e.g., electric road vehicles) or specifically refer to cars (e.g., battery electric cars). While it is reasonable to assume that electric motorcycles fall under the umbrella of electric vehicles whenever addressed in policies and legislations, if this proves not to be the case, then additional barriers might arise in the development of scaled-up projects such as the one assessed in this study. Another remark refers to the fact that there are ongoing discussions regarding a proposed ban on motorbikes within Hanoi's inner city by 2030. Identified references to this potential ban only mention "motorcycles", without specific possible differentiation for electric motorcycles. Should this ban materialise, it could jeopardise the feasibility of electric moped projects.
	Alignment with supra-national, national, city legislation & regulations	
	Ease of implementation (considering	
	Administrative barriers	
Effect on climate	Effect on GHG emissions	The use of e-mopeds results in a theoretical reduction in monthly average CO2 (greenhouse gas (GHG)) emissions of 32 kg WTW. The total pilot has a theoretical CO2 reduction of 193 kg WTW. This theoretical reduction in GHG emissions comes from passengers switch from taking the shuttle bus to the e-mopeds. When there is an actual reduction in shuttle km (e.g. shuttle rides are reduced), only then there is a substitution of vehicle km and actual reduction of GHG emissions. Since there is no indication of a reduction in shuttle rides or kilometres, the effect on climate remains potential. The scale up (50 routes) takes into account that there is a passenger km substitution which results in 616 tons of CO2 reduction WTW.

HIGH LEVEL KPI	LOWER LEVEL PI	FINDINGS
Effect on environment	Effects on air pollutants	Following the reasoning of theoretical and actual substitution of vehicle km, the pilot results in a theoretical reduction in **air pollutants** of 975 grams NOx and 17.7 grams PM10. The scale up (50 routes) results in a substitution of vehicle km and results in a reduction of 3.1 tons of NOx and 56.3 kg of PM_{10}.
Effect on society	Effects on traffic safety	A shift from two-wheelers to public transport on the road results in higher traffic safety. Given that the pilot results in more two-wheeler km's, and also overall vehicle km, given that the shuttle is assumed to be driving its regular service, results in lower traffic safety. The effect is expected to be minor, given the relatively low amount of kms driven by the e-mopeds in the pilot. The scale up assumes a lot more two-wheeler kms, and although there is a substitution of vehicle kms, will result in lower traffic safety.
	Effects on charging safety	The effect on **charging safety** in the pilot and the scale-up is hard to gauge, but the risk is assumed to increase given that more charging infrastructure will be required and no dedicated e-moped charging safety standards exist in Vietnam. However, this risk is expected to be mitigated in the future as charging service providers already exist and standards for electric vehicles in general are available.
	Effects on accessibility	The **accessibility** improvement for society is expected to be minimal as the e-mopeds must travel between stations, which are placed at existing boarding locations for the shuttle. The network is therefore not extended. However, as the e-moped fleet is assumed to be large enough to accommodate travellers immediately, the **travel time** is expected to decrease due to the lack of waiting time.
	Effects on affordability	On the **affordability** side the effects are partially unknown as the pilot offered the e-mopeds free of charge and the Mall subsidizes the current shuttles. If the subsidy is applied to the e-mopeds at the different sites the affordability for the traveller will stay the same at best, but is not expected to improve as the shuttles are already free.
	Effects on security	The **effect on security** was evaluated using the estimated annual number of motorbike theft incidents. There was no reliable source with available data directly from Vietnam, so benchmarks from neighbouring countries were used for comparison and calculation a proxy for Vietnam's motorcycle theft rate (as a percentage of motorcycle stock). The total number of e-mopeds involved in the scaled-up project (5,000) is minimal in comparison to Vietnam's total stock of motorcycles (estimated to be around 72 million by 2020), only a few dozen additional motorcycles are expected to be stolen as a result of the scaled-up project. Due to a lack of specific data, it was estimated that e-mopeds and conventional motorcycles share the same percentage of motorcycle theft (as a share of motorcycle stock) of 0.08%. However, it is reasonable to expect that e-mopeds might get stolen more frequently than conventional motorcycles, since stolen electric motorcycles can be sold or disassembled for parts at a higher profit than conventional ones.
	Effects on service quality	**Service quality** is expected to increase, based on the survey results from the ex-post assessment. The travellers particularly appreciated the improved comfort, driveability and journey continuity in the pilot. The weather suitability and perceived safety of the e-mopeds was scored less favourable than the other topics, but neutral to slightly positive with respect to the current shuttle service.

HIGH LEVEL KPI	LOWER LEVEL PI	FINDINGS
Effect on wider economy	Effects on national budget	Following the reasoning of theoretical and actual substitution of vehicle km, the pilot results in a theoretical reduction in **air pollutants** of 975 grams NOx and 17.7 grams PM10. The scale up (50 routes) results in a substitution of vehicle km and results in a reduction of 3.1 tons of NOx and 56.3 kg of PM_{10}.
	Effects on employment	Regarding the **effect on employment**, the scaled-up project is expected to generate a job surplus of 450 jobs when accounting also for the effect of potential job losses in conventional shuttle services (affected by a larger-scale introduction of e-mopeds). Although the overall effect on employment is positive, when compared against Vietnam's total labour force (estimated at approximately 55.7 million people in 2022lxi), the projected impact remains marginal.

RECOMMENDATIONS

For future work on the implementation of e-mopeds in Hanoi the authors would like to make a few recommendations, both on the implementation and on the assessment of the process.

- The nature of e-mopeds, especially in the current implementation is rather local: shuttle routes of a few km's are being targeted, travel times are around minutes. However, the current assessment has a very wide scope that targets changes on a national level. While this is understandable from a policy point of view, the effect becomes rather negligible when looking at that level. The effect on a local level could be very pronounced, but when zooming out to the level of a city or a country the effects are diluted. The recommendation is to steer future assessments towards a local approach (on neighbourhood or district level) where each shuttle route is assessed separately, as small changes in the shuttle route can have an impact on the effectiveness of the e-moped service.
- On the implementation itself the recommendation is to investigate if e-mopeds can replace other modes of transport than the shuttle. By focussing on shuttles, which are a relatively safe mode of transport, the improvement is less pronounced as the reduction in safety offsets the reductions in emissions. If however, fossil fuelled mopeds would be targeted for replacement by e-mopeds, the reduced emissions are not offset and the net gain is higher. Finally, the roll-out proved to be challenging due to issues in finding a partner for setting up the IoT devices on the mopeds such that users could rent them via an app. Before further roll-out the focus should be shifted towards getting one site fully operational and user friendly before replication to other sites.
- On the assessment process, the collaboration for an European knowledge institute with local stakeholders proved difficult due to differences in approach and physical distance. The recommendation is to give a local knowledge institute a prominent, leading role in such an assessment as they are better aware of local processes and know how to approach stakeholders effectively. External institutes (from other countries) could be involved, but perhaps only for a few consulting and knowledge exchange sessions.
- Sensibility should also be taken into account when building further on the current assessment. Most KPI calculations are very sensitive to the initial assumptions. While those assumptions are valid for the demo pilot site, it is hard to validate them when scaling up to many different sites. It is recommended to approach each site separately in a future assessment, or apply certain categorization such that assumptions can be used for similar sites.

CONTENTS

1 BACKGROUND AND CONTEXT

Vietnam is experiencing rapid economic growth – between 2011-2021 it had a 5.9% yearly GDP growth on average[1] - and with an increase in urban population growth of 3% per year[2] this results in a rapid increase in transport demand.

The flow of vehicles in Vietnam has grown strongly in the past decades. The country's almost 95 million inhabitants in 2018[3] owned 3.9 million cars and 58.2 million motorbikes and mopeds[4]. The average annual growth rate of cars was around 13.7% from 2014 to 2018, while in the same period motorbikes and moped ownership grew by 9%[5]. Personal two-wheelers are the main means of transportation in Vietnam with a high rate of up to 92%. In addition, 100% of motorcycles using internal combustion engines (ICE) in Vietnam run on gasoline. Currently, the total number of vehicles with a cylinder capacity of 175 cm^3 or less accounted for 99.9% of the total number of motorcycles in Vietnam[6]. About 87.6% of the motorbikes in Vietnam belong to the Japanese brands: Honda and Yamaha[7].

Keeping up with the challenges brought about by further urbanization, particularly in terms of providing proper transport infrastructure and support services, is becoming a key issue for the country. Land space allocated to urban transport is relatively small compared to other urban centres in the region, only 6%-15% of land is allocated to urban transport in Vietnam as compared to 20%-30% in other countries . The same source8 also points out that the passenger public transport system has not been able to fully meet travel demand and that the big mass transit projects have been missing the deadlines. Urban areas are estimated to contribute 70%-75% of the total GDP of the country.

1.1 GEOGRAPHY AND THE SOCIAL/URBAN CONTEXT

Hanoi, the capital of Vietnam, is home to approximately 7.5 million residents. It is the second most populated city in the country (around 8% of the total population of Vietnam)3 and features an urban area of roughly 320 square km . The city is also the cultural, commercial and educational centre of Northern Vietnam. The Hanoi Capital Region (or the Hanoi Metropolitan Area) is composed of the City of Hanoi and its adjacent municipalities, and is home to 16.1 million inhabitants (24 thousand square km).

The climate in Vietnam is characterized by a wet and dry season, with the exact period of the season varying by latitude. Hanoi, for example, experiences the wet season from roughly May to September. Average temperatures range from 14 to 34 degrees Celsius throughout the year, with the higher temperatures coinciding with the wet season.

The heavy monsoons, with monthly precipitation values of >200 mm , can cause issues on its own but also result in flooding, such as in Southern Vietnam.

1.2 URBAN TRANSPORT

This section briefly discusses the urban transport system of Hanoi, focussing on the modal split of the trips and the vehicle fleet.

1.2.1 Modal shares

Urban and trunk roads make up the majority of Hanoi's urban transportation system. Airports, inland canals, and railways are present, however they are mostly used for intercity transportation. Private transportation modes dominate the urban transportation landscape, especially motorcycles are increasingly popular and take about 73% of the number of trips in Hanoi. The bus comes second in popularity with a modal share between 9 and 10 % and after that the private car and car taxi follow, both about 6%. The remaining trips are roughly equally distributed over bicycle- and motorcycle-taxis[11].

1.2.2 Vehicle fleet

As noted earlier, the motorcycle and car ownership is steadily growing by about 9-13% in a four-year period. In the longer period from 1990 to 2020 motorcycle ownership experienced a 53-fold increase, car ownership increased by a factor of 36[11].

The high-level vehicle fleet constitution at the end of 2022 is shown in Figure 1. In addition to the local vehicles, about 1.2 million vehicles from the surrounding provinces and cities visit the city and participate in the traffic system.

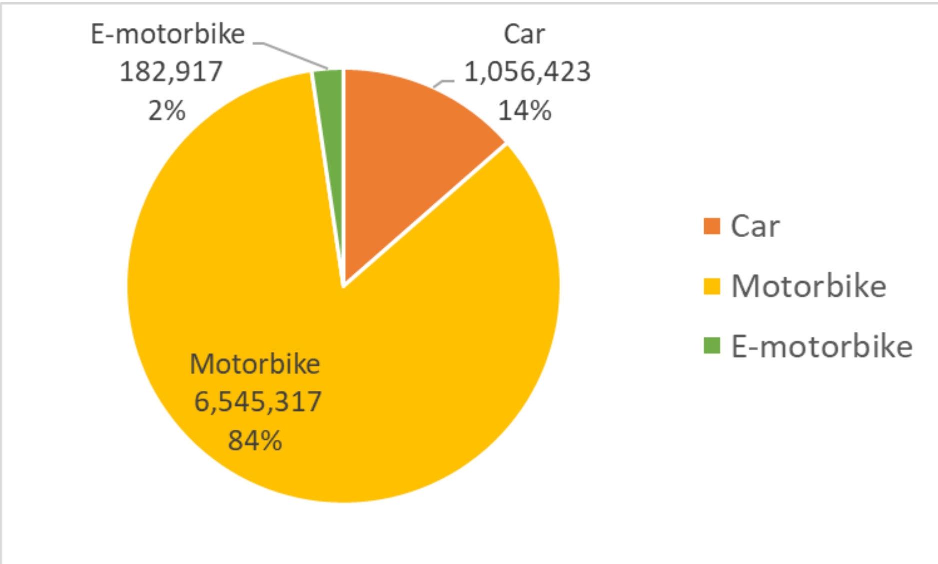

Figure 1: Hanoi fleet composition in 2022 [12]

1.2.3 Public transport

Public transport in Hanoi consists of two fundamentally different systems. A system organized for large vehicles operating in fleets on fixed line and a system operating independently and mainly serving individual passengers. Fleet-based operations consist of buses planned and operated by the city. The individualized system includes motorbike taxi, bicycle taxis (most of them have been banned in the city centre) and car taxis.

As of 2022, Hanoi has 154 bus routes of which 132 are subsidized, 8 are non-subsidized, 12 routes go to neighbouring localities and 2 provide a city tour, all together total serving all the 30 districts12.

1.3 IDENTIFICATION OF MAIN PROBLEMS

The survey conducted by Indochina Research13 in Hanoi and Ho Chi Minh provides several factors hindering people from using public transportation, the lack of familiarity being the main factor for over half of the 189 respondents, all reasons are shown in Figure 2.

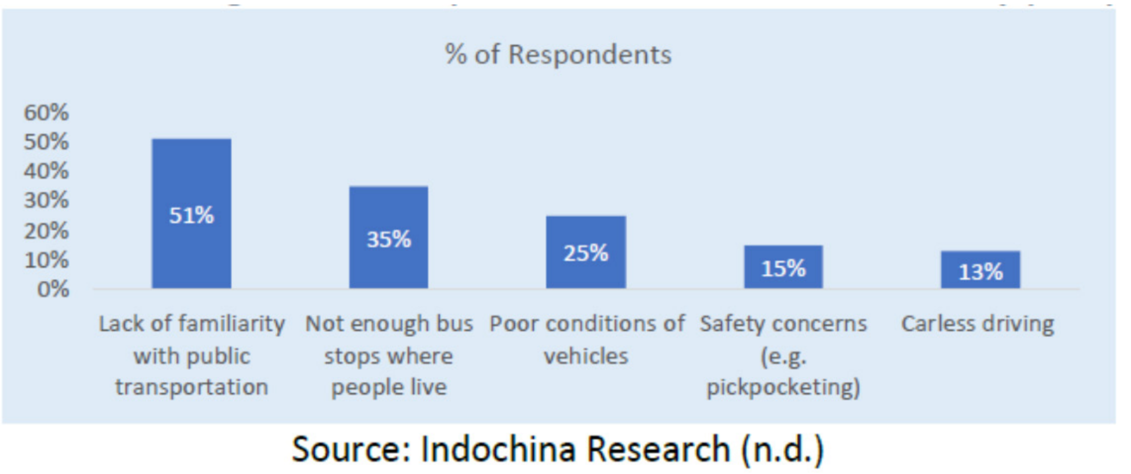

Figure 2: Reasons why respondents choose not to use public transportation [13]

TRAMOC recently mentioned that only 12% of residents in Hanoi use bus services. Currently, the on-time performance of the buses is a main concern, as more than 50% of the bus schedules are delayed.

Another key related issue in Vietnam is road safety. While the country has had significant improvements in terms of lowering fatalities and road crashes, approximately 14,000 people still lose their lives every year on Vietnam's roads[14]. The National Traffic Safety Committee (NTSC) states that around 70% of road crashes involve motorbikes. High school students are the most vulnerable road users in Vietnamese cities like Hanoi (90% of road crash victims are high school students) according to the NTSC[15].

The extreme weather in Vietnam – monsoons and flooding – is considered as one of the barriers to the development of electric mobility. Extreme weather conditions such as rain, wind or flooding can cause fire and other damages to the battery units and electrical system. Using or storing electric vehicles in hot weather can also damage the battery units, reducing their lifespan, performance and energy discharge duration. One possible solution for this case is improving the technical quality of electric vehicles, particularly the quality of batteries/electric systems. Another is to provide a dry and cool environment where batteries and e-mopeds can be stored when not in use.

1.3.1 Barrier of psychology, awareness of using electric vehicles

There exists a perception of users that operating electric vehicles is not as safe as driving gasoline vehicles due to perceived risk of electric shock, fire and a lower durability. According to a project of electric vehicle testing at University of Transport Technology, users of electric vehicle are most concerned about safety factors. In the safety group, users are most concerned about the safety of batteries when being charged and moving on roads (risk of fire, electric shock).

In Vietnam, thanks to compact designs, low cost, strict control on technical quality and absence of an age limit for driving the vehicles, electric bikes gradually become popular means of transport. For a long time, many providers have distributed poor-quality electric vehicles with unidentified origins. The common feature of these models is that after about one year of use, most of them are degraded. These vehicles have shown signs of slow acceleration, unstable power supply, lower battery capacity, damage in accumulator, etc. Even some low-quality accumulators cause fire and explosion during charging or use. The lifespan of these products is short, many shall be abandoned or sold at low prices due to failure after just 2 years of use.

Since Circular No. 41/2013/TT-BGTVT dated November 5th, 2013, stipulating technical safety and quality inspection of electric bikes manufactured and assembled domestically and imported became effective on January 1st, 2014, the quality of electric bikes in Vietnam has been increasingly strictly controlled.

Another safety risk is that electric vehicles in traffic almost make no noise, so with the traditional traffic habit, electric vehicles may not attract attention from pedestrians and drivers. The consequences of traffic safety risks are much higher than that of (more noisy) vehicles with an internal combustion engine. The European Union is expecting, by 2021, to enforce a requirement that all the electric vehicles shall be fixed with noise-generating devices to deal with the problem that these new-generation vehicles do not make any sound when moving.

1.3.2 Barriers related to environmental impacts due to the use of electric vehicles

Electric vehicles are considered a clean and environmentally friendly transport means as they have no tailpipe emissions, improving air quality locally. However, they still contribute to greenhouse gas effects due to the charging process for the battery/accumulator system and using power from the grid of power plants that use fossil fuels (coal, oil and gas).

According to reports by the Ministry of Industry and Trade, it is expected that in 2030, the power output generated by coal-fired thermal power plants will account for over 53% of the country's total power output. As such, coal-fired thermal power will still make up more than half of Vietnam's power output by 2030, not to mention coal-fired thermal power plants using oil and gas. Thus, the use of electric vehicles in Vietnam where the power source mainly comes from thermal power means that the environmental pollution will partially move from places where vehicles are used to places where power plants (using fossil fuels) are located. This situation is expected to improve as power plants are expected to rely less on coal in the future. Additionally, the parts of electric vehicles must be discarded appropriately at the end of life, causing a great risk of environmental pollution, particularly accumulators and lithium batteries which require huge costs and modern technologies to be treated then.

1.3.3 Barriers in policy

Currently, transport policy systems including laws, decrees, directives, etc., on electric vehicles in Vietnam are not widely developed. The country has some e-mobility policies in place, but additional regulations are necessary to support e-mobility further, namely: policies on transportation, policies on import and export, policies on production, policies on energy and environmental protection, policies on encouraging research and development as well as policies on raising awareness of using electric mobility. This is crucial that allows electric vehicles to be safely operated, meeting people's travelling demand and protecting the environment.

1.4 DESCRIPTION OF DEMONSTRATION PROJECT

The demonstration will be conducted in phases from November 2022 to May 2023. For the first phase, there will be a trial with 50 shared e-moped to test the sharing system to facilitate the traveling from BRT stop to a shopping mall and vice versa. A map of the route is shown in Figure 3, and the used e-moped type is shown in Figure 4.

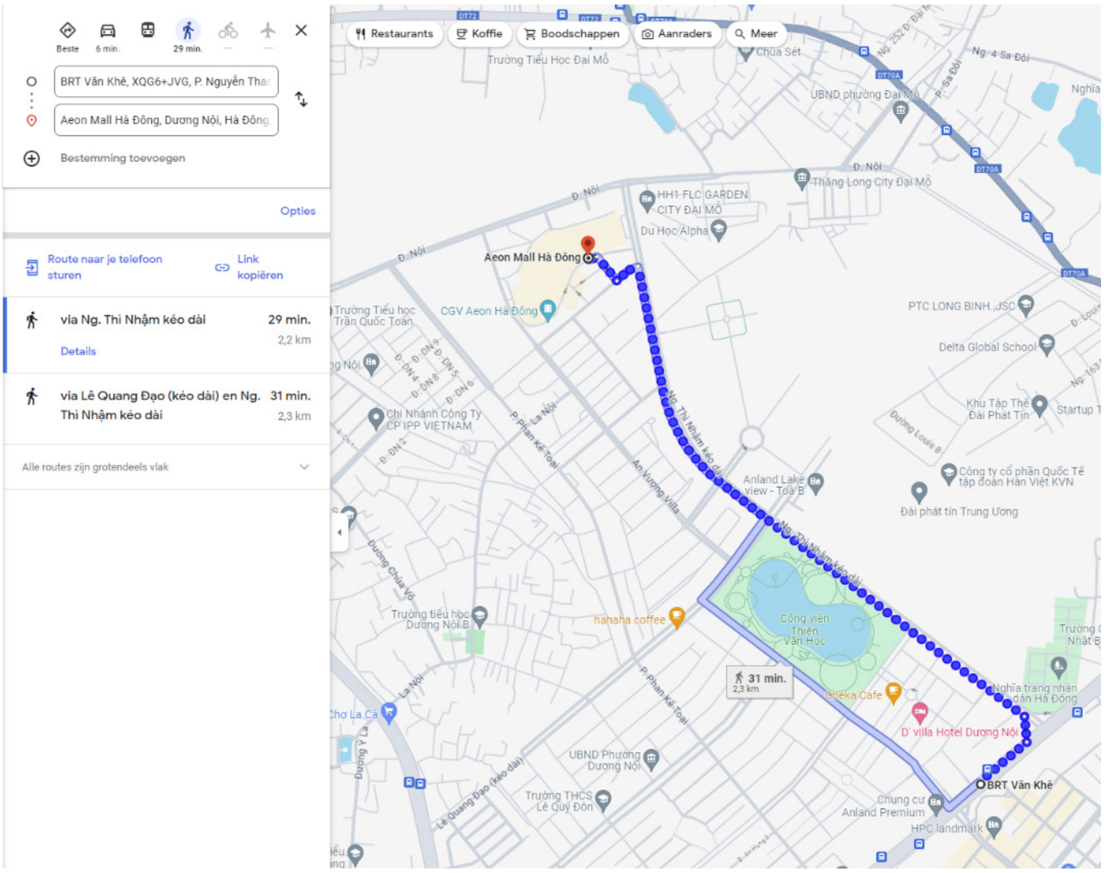

Figure 3: Map of the trial route between the BRT stop and the Aeon Mall

Figure 4: Vinfast Ludo e-moped

There will be periodically assessment on the system to see what is good, what needs to be improved for the better pilot. After that the sharing system will be replicated to other locations in the city, probably connecting the Metro terminal with residential areas.

- OUTCOME 1. E-mobility solutions to enhance the last-mile connectivity.
- OUTCOME 2. Conditions for enabling accelerated e-mobility uptake and integration are improved.
- OUTCOME 3. Local capacities relating to e-mobility are enhanced.

Smart services, fleet bundling, E-moped GPS positioning that support eco-routing will also be part of the project (SOL+ MaaS App). The demonstration project will have a high potential to not only make e-mobility attractive but also reduce the GHG emissions from transport and increase the share of public transport use.

1.5 RELEVANT STAKEHOLDERS AND USER NEEDS

1.5.1 Aims of the city and Expectations of Stakeholders involved in the demo

The project's objective is to form the habit of using green traffic modes and raising awareness of environmental protection for people of Hanoi city, application of science and technology in the management and operation of public transport and connection of public transport in the city.

Hanoi Department of Transport highly appreciates the pilot project. The basic scheme is suitable as one of the solutions to strengthen the management of road vehicles in order to reduce traffic congestion and environmental pollution in Hanoi city.

There were 18 stakeholders identified within five stakeholder groups. The groups range from national and city authorities, public transportation companies, local manufacturing companies and service providers, NGOs and environmental organisations, and universities and research institutes. The different stakeholders participated in different User Need Assessment (UNA) activities, as described in Table 1.

Table 1: Overview of stakeholders and User Need Assessment (UNA) engagement

STAKEHOLDER GROUP	ORGANIZATION/ DEPARTMENT	UNA ACTIVITIES
National Authorities / City Authorities	National Traffic Safety Committee (NTSC)	Interview, survey and KPI weighting
	Hanoi Department of natural resource and environment (DONRE)	Interview, survey and KPI weighting
	Hanoi Department of Transport	2 Survey inputs
	Department of Environment, Ministry of Transport	survey
	Transport Development Strategy Institute (TDSI)	Interview, KPI weighting factors
	Department of Science, Technology and Environment (DSTE)	Interview, KPI weighting factors
	Hanoi Urban Transport Management and Operation Center (TRAMOC)	Interview, KPI weighting factors

STAKEHOLDER GROUP	ORGANIZATION/ DEPARTMENT	UNA ACTIVITIES
Public Transport company	Hanoi Transport Service Company (Transerco)	Interview, survey and KPI weighting
	Hanoi Bus Rapid Transport management	Interview, KPI weighting factors
Local Manufacturing Companies / Service providers and energy companies	Honda Vietnam	Interview, survey
	QiQ	Interview, KPI weighting factors
	CODATU	Interview, KPI weighting factors
	AEON Mall	Interview, KPI weighting factors
NGOs and Environmental organisations	Clean Air Asia	Interview, KPI weighting factors
	UN environment	Interview, KPI weighting factors
	Vietnam Clean Air Partnership	Interview
	RCEE-NIRAS	Interview, KPI weighting factors
Universities and research institutes	Hanoi University of Transport Technology (UTT)	Interview, KPI weighting factors

1.5.2 Regulation

In Vietnam, regulatory framework on e-mobility is still in the early stage. Framework supporting EV deployment has not been fully developed. Nonetheless, deployment of EVs, effort to cut GHG emissions, and support from the local EV industry have recently brought the topic onto policy agendas. There have been several government strategies favouring EV deployment which are listed in Table 2. However, 13 polices listed in the Table 2 are still general and not specific to e-mobility. The main points of these policies are promoting cleaner vehicles (including e-vehicles) and developing fuel consumption standards for internal combustion vehicles. Therefore, there is the need for intensifying the required effort in developing a sperate national regulations on e-mobility.

Table 2: Key government polices support EV deployment in Vietnam.

LEGAL DOCUMENT	YEAR ISSUED	NAME OF DOCUMENT	EV-RELATED CONTENTS
Decision No. 2139/ QD-TTg	2011	National Climate change strategy	Promotes low-carbon emission vehicles
Decision No. 432/ QD-TTg	2012	National Sustainable Development Strategy	Controls and reduces air pollution from transport activities

LEGAL DOCUMENT	YEAR ISSUED	NAME OF DOCUMENT	EV-RELATED CONTENTS
Decision No. 2139/ QD-TTg	2011	National Climate change strategy	Promotes low-carbon emission vehicles
Decision No. 432/ QD-TTg	2012	National Sustainable Development Strategy	Controls and reduces air pollution from transport activities
Decision No. 1393/ QD-TTg	2012	National Green Growth strategy period 2011-2020 vision to 2050	Reduces GHG emissions, promotes cleaner vehicles
Decision No. 1168/ QĐ-TTg	2014	Development strategy for Vietnam automobile industry to 2025, vision to 2035	Encourages the production of eco-friendly automobiles (including electric vehicles)
Law No. 106/2016/ QH13	2016	Amendment to some articles of the Law on VAT, the Law on SCT, and the Law of tax administration	Introduces SCT, which favours EVs (applied for cars only)
Decision No. 985a/ QĐ-TTg	2016	National action plan for air quality management to 2020, vision to 2025	Develops the mechanisms and policies on managing and promoting EVs, within MOT
Decision No. 2053/ QD-TTg	2016	National action plan for implementing Paris Agreement	Mandates MOT to develop and implement the action plan for cutting GHGs in the transport sector to meet NDC targets
Resolution No. 55-NQ/TW	2020	Resolution on Orientation of National Energy Development Strategy to 2020, Vision to 2045	Prioritizes the effective utilization of all renewable energy resources and the development of a smart and efficient power grid); promotes electric vehicles
Resolution No. 136/ NQ-CP	2020	Resolution on sustainable development	Promotes sustainable energy. Gives MOT responsibility for developing vehicle fuel consumption standards and encouraging the use of clean fuels
Resolution No.140/ NQ-CP	2020	Resolution of the action plan for implementation Resolution No.55-NG/ TW	Gives MOT authority to develop and apply fuel consumption standards; promotes clean vehicles (including EVs)
Law No. 72/2020/ QH14	2020	Law on environmental protection	Develops preferential policies to promote low fuel consumption, low or zero-emission vehicles, and vehicles used renewable energy. Develops the roadmap for transitioning and eliminating vehicles that use fossil fuel
Directive No. 3/CT-TTg	2021	Directive on controlling air pollution	Authorizes MOT to develop national programs on developing and encouraging use of environmentally friendly transport modes, including electric vehicles. MOIT develops policies on exploiting, processing, and importing raw materials (lithium, ...) for battery production of electric vehicles; and grid capacity to meet the demand of increase in EV in the future

LEGAL DOCUMENT	YEAR ISSUED	NAME OF DOCUMENT	EV-RELATED CONTENTS
Decision 452/ QĐ-BGTVT	2021	MOT's action plan responds to climate change, enhances resource management and protects the environment over the period 2021-2025	Reduces GHG emissions in the transport sector; develops regulations on energy labelling for electric cars, hybrid cars, electric motorcycles, and motorcycles; promotes cleaner vehicles including EVs; develops the fuel consumption standards for passenger cars and two-wheelers

1.5.3 Obstacles, limitations, barriers

EV adoption is one of the goals in Vietnam, due to urban air pollution and GHG emissions. However, there are several major obstacles to the adoption of EVs, including: market barriers, technical and infrastructure and, policy barriers[17]. In the report for NDC Transport Initiative for Asia (NDC-TIA), a consulting team conducted a survey with a total of 1337 vehicle owners and passenger transport enterprises in 12 districts of Hanoi. According to the survey's findings, there were three main factors considered to be the biggest EV market barriers, including: (1) vehicle price; (2) battery technology; (3) supporting technical infrastructure (no place to charge, repair, maintain, replace...).

1.5.4 Sustainability of the e-Mobility solutions to be implemented

Urban air pollution and GHG emissions are the most prominent issue related to life quality in big cities such as Hanoi. Vietnam aims to reduce its GHG emissions and air pollution and is embracing international and national commitments to achieve this. Vietnam submitted its NDC (Nationally Determined Contribution) to the UNFCCC in September 2020 with a target to reduce GHG emissions by 9% (with only domestic resources) and 27% (with international support) by 2030. The transport sector currently contributes about 18% of total national GHG emission[16]. To reduce air pollution in the nation, the government issued Directive 03/ CT-TTg on reinforcement of controlling air pollution in January 2021. The Directive requires many government agencies to take actions, especially the Ministry of Transport is required to launch national initiatives to promote the use of environmentally friendly transportation options, such as electric vehicles. Compared to internal combustion engines (ICE) vehicles, e-vehicles generate much lower emissions and less noise. In order to reduce GHG emissions, air and noise pollution, mitigate climate change, and advance the development of sustainable transportation in Vietnam, e-mobility adoption is necessary.

1.5.5 Impact on existing business models

Within the limit of the pilot demo project (50 shared e-mopeds) it is not yet capable of changing the current transportation business models. However, the project attracts attention and increases people's awareness about the use of electric vehicles to reduce adverse impacts on the environment and climate. At the same time, the pilot program lays the foundation for the scale-up scenario where far more e-mopeds will be used in the city. This might compete with existing mobility options, such as the shuttle, and create an impact on those existing business model. The competition of the e-moped might mean that additional subsidy is required for shuttles to compensate for the reduced ridership and keep the shuttles available for those that cannot, or do not want to, use e-mopeds.

1.5.6 Implications for Planning and Urban Development

The development of transport policies and regulations in Vietnam is generally guided by four major national strategies, including: (1) the National Climate Change Strategy (Decision No. 2139/QD-TTg), (2) the National Sustainable Development Strategy (Decision No. 432/QD-TTg), (3) the National Green Growth strategy (Decision No. 1393/ QD-TTg), and (4) the Environmental Protection Law (Law No. 72/2020/QH14). Based on these strategies, specific action plans and administrative decisions are executed.

Under the national government, several governmental authorities are directly involved in the Vietnam e-mobility revolution. Figure 5 shows on what level different stakeholders operate and interact. Department of Planning and Investment (DPI), Department of Finance (DOF), Department of Trade and Industry (DOIT), Department of Transport (DOT), Department of Science and Technology (DOST) and the Department of National Resource and Environment (DONRE). These ministries oversee strategic policies in the EV industry and other concerns related to EV deployment such as urban plan development, national energy network, and long-term investment issues. The suppliers and manufacturers on the operational level are dependent on the choices made a the strategic level as that drives their choice for operations and investments.

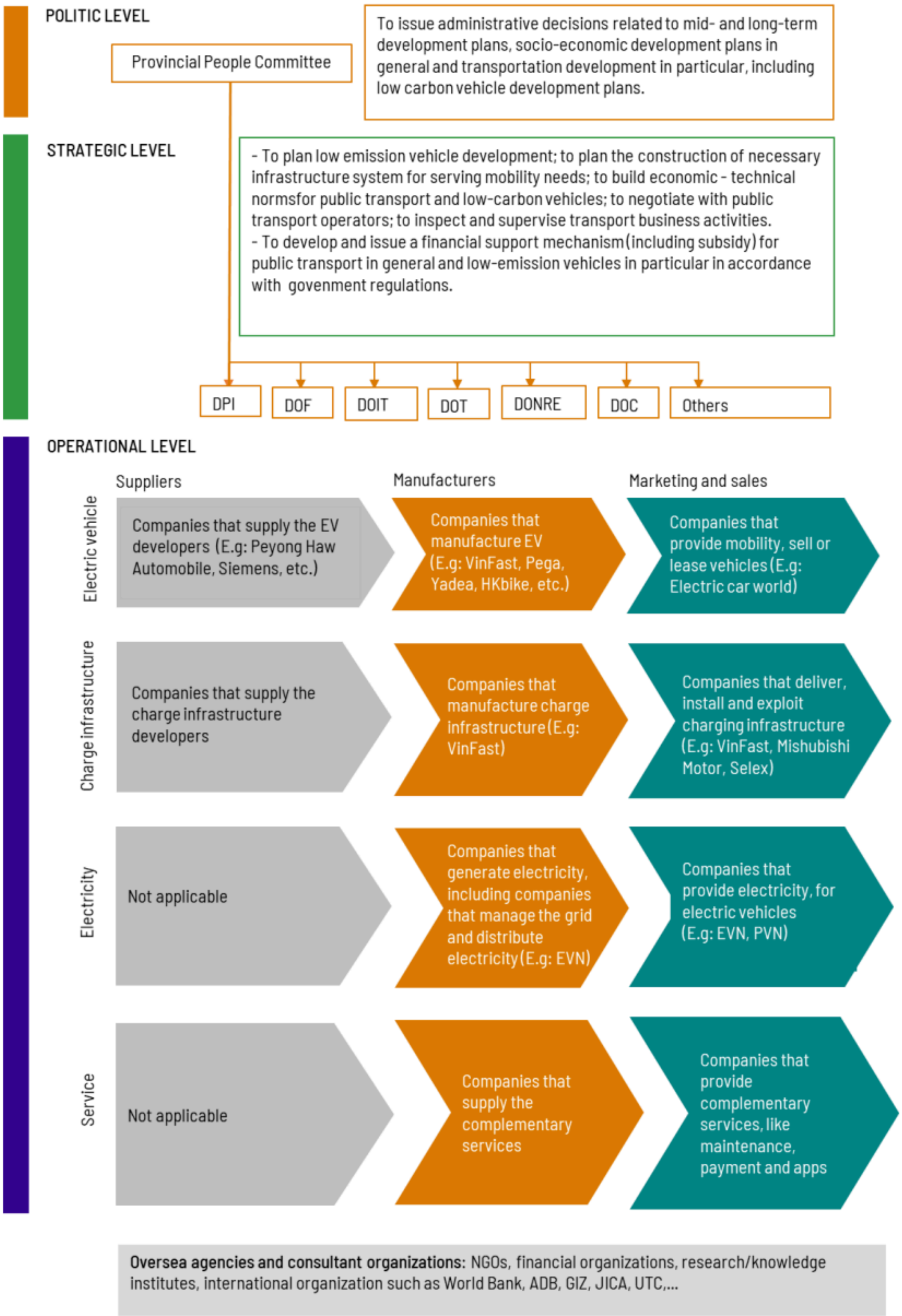

Figure 5: Stakeholder mapping in e-mobility in Vietnam [17]

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2 KEY PERFORMANCE INDICATORS (KPIS)

2.1 PRIORITIZATION OF KPIS ADDRESSING THE SPECIFIC CITY NEEDS

The priorities given to each attribute (KPI) are derived from interactions with the relevant stakeholders. The weighting of the attributes for the Hanoi demonstration was done in combination with interviews held with 13 stakeholders from the list provided in Table 1 based on their availability. The weighting process followed the stratified KPI structure depicted in Figure 6, in which the stakeholders provided their priority for indicators on different levels of detail (level 1, level 2, and level 3), as described further in the next paragraphs. For a detailed explanation on the prioritisation methodology, please refer to deliverable D1.6 Impact assessment results Volume 1: Overview.

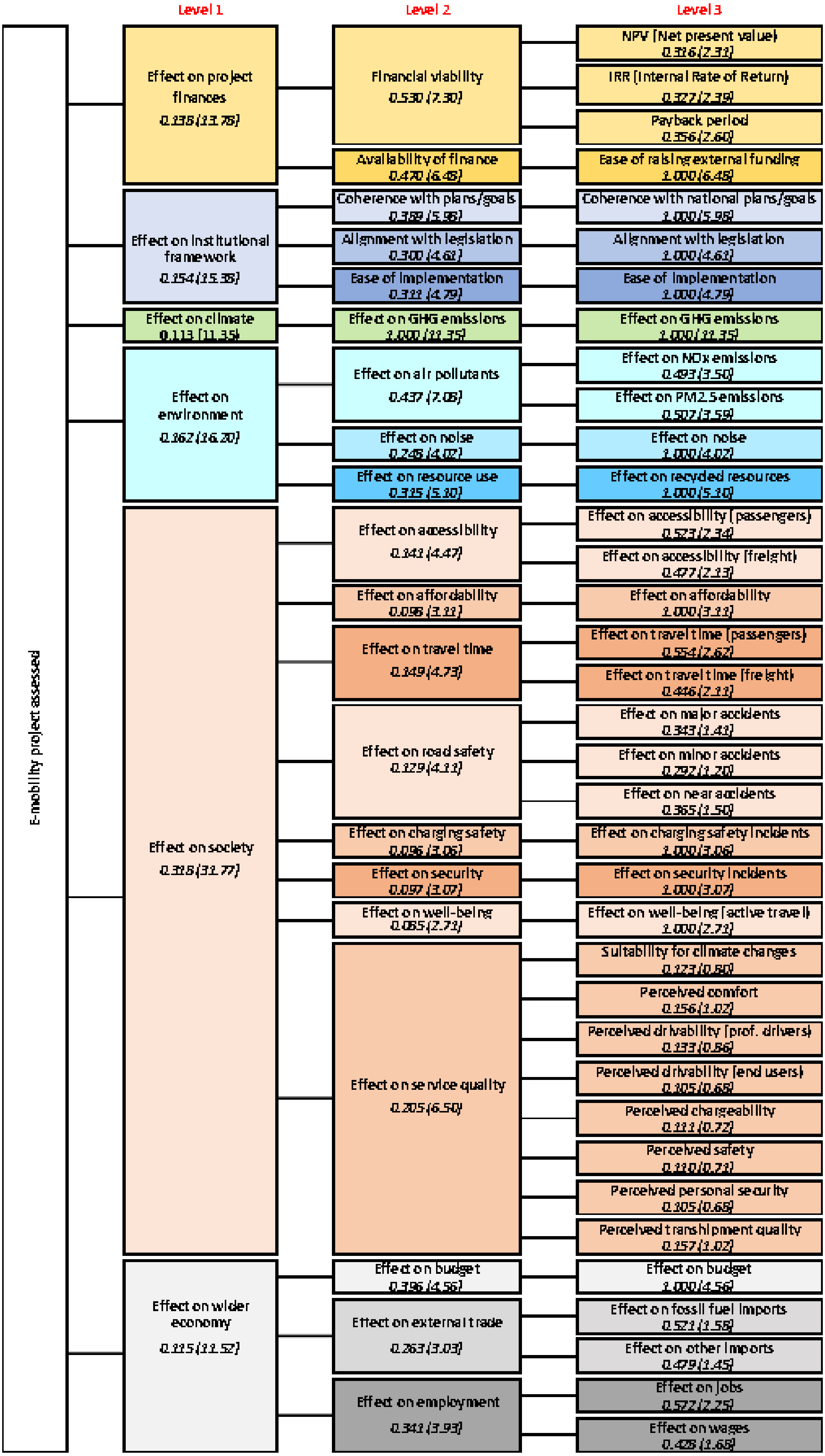

Figure 5: Stakeholder mapping in e-mobility in Vietnam [17]

Based on the interviews, mean values of the weights as provided by the 13 stakeholders were calculated. These are presented for all indicators (level 1, level 2, and level 3), as depicted in Figure 6. For every indicator, both relative (outside brackets) and cumulative (between brackets) weights are presented. The relative weight of an attribute represents the average of the weights assigned by all 13 stakeholders for that attribute. For example, the weight of 0.138 for effect on project finances (level 1) represents the average of the weights assigned by all stakeholders for this level 1 KPI. Similarly, the weights of 0.530 for financial viability (level 2) and 0.356 for payback period (level 3) represent the averages of the weights assigned by all stakeholders for these respectively level 2 and level 3 KPIs. Therefore, relative weights indicate stakeholders' priorities within a family and sum up to 1.

Cumulative weights, in turn, are obtained for each level by applying the relative weights of that level to the cumulative weight of the parent attribute. In the case of level 1 KPIs, the cumulative weights are identical to the corresponding relative ones, only expressed at a different scale (out of one hundred instead of out of one). For example, the cumulative weight of 7.30 for financial viability (level 2) represents the relative weight of this KPI multiplied by the cumulative weight of the parent KPI, which is effect on project finances (i.e., 7.30 = 0.530 x 13.78). Similarly, the cumulative weight of 2.60 for payback period (level 3) represents the relative weight of this KPI multiplied by the cumulative weight of the parent KPI, which is financial viability (i.e., 2.60 = 0.356 x 7.30).

By analysing the cumulative weights of level 1 indicators in Figure 6 , one can observe that effect of society emerged as the main priority of the stakeholders, followed by effect on the environment (2nd), effect on institutional framework (3rd), effect on project finances (4th), effect on wide economy (5th), and effect on climate (6th). It is interesting to notice that the KPI society scores almost twice as high compared to the weight the second highest KPI (effect on the environment).Thea other KPI's follow a much more stable downturn of priorities until the last KPI (effect on climate). Another interesting aspect of the results refers to the fact that effect on the environment, such as effect on air pollutants, noise and resource use emerged as the second highest priority, whereas the effect on climate (GHG emissions) emerged as the last priority.

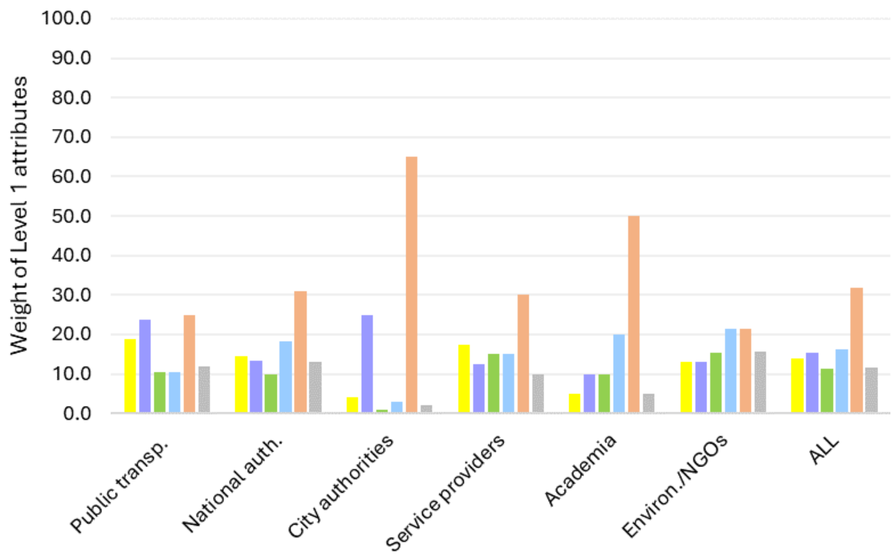

Figure 7: Level 1 weights by stakeholder group

Regarding level 1 KPIs, effects on society was not only the main priority of the overall stakeholders (ALL in Figure 7), but also the top priority for all the stakeholder groups. This was especially true for city authorities, academia, service providers and national authorities, for which the priority for the effects on society was between 1.8 and 3.9 times greater than the average within these stakeholder groups.

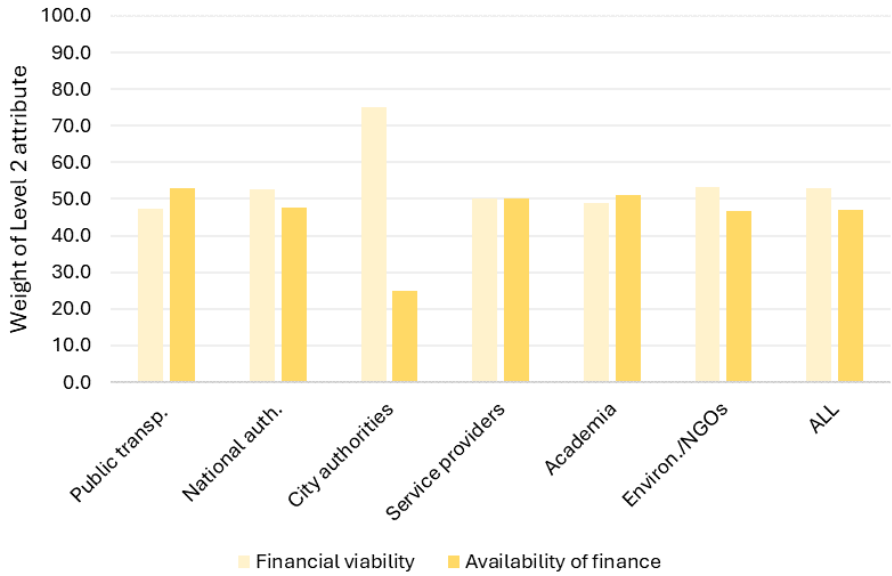

Figure 8: Level 2 weights on project finances by stakeholder group

For the level 2 indicators within the level 1 indicator project finances, the overall observed distribution of preferences depicted a very stable pattern, with both financial viability and availability of finances indicators receiving around 50% of the weight. City authorities, however, depicted a very different behaviour, in which financial viability received a priority three times higher than the availability of finance (see Figure 8).

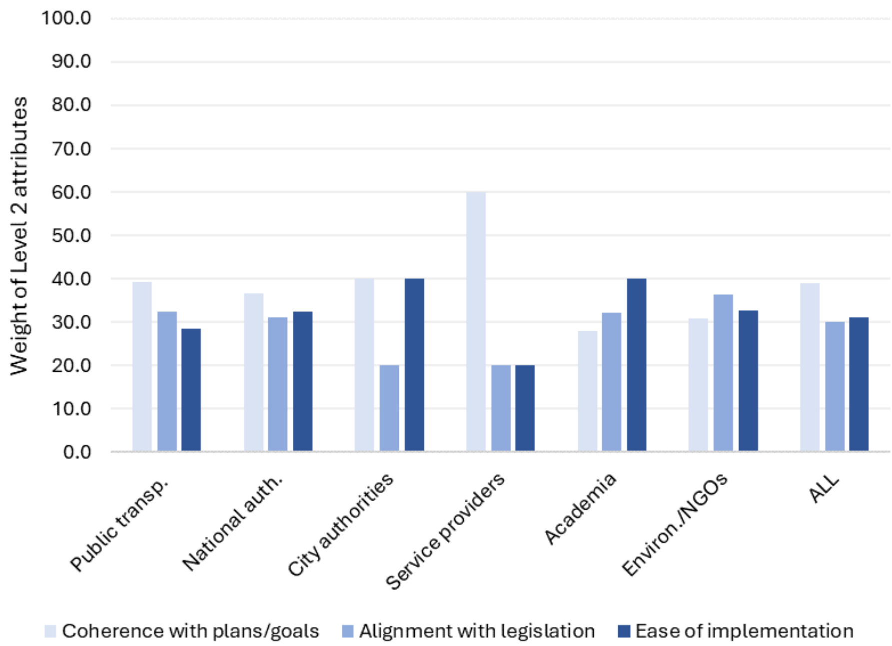

Figure 9: Level 2 weights on institutional framework by stakeholder group

Regarding the level 2 indicators within the level 1 indicator institutional framework, different stakeholders depicted different perceptions of which level 2 indicator had the highest priority, but usually by small differences (see Figure 9). The Service providers group was the only outlier, with a clear preference for coherence with plans/goals (which depicted a weight three times higher than the other two indicators for this group). Public transport, national authorities and the overall assessment (ALL) also showcase a higher importance given to the coherence with national plans, whereas academia stakeholders assigned higher importance to ease of implementation and environmental/NGOs assigned higher importance to alignment with legislation.

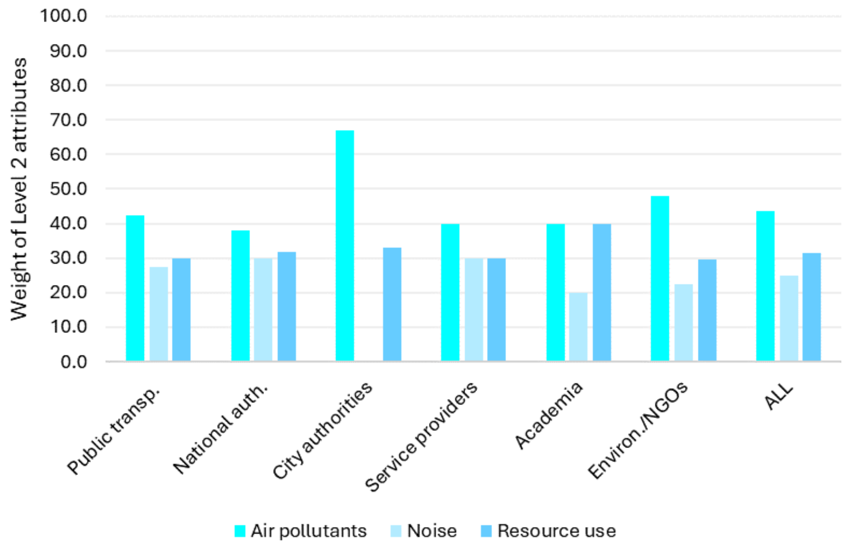

Figure 10: Level 2 weights on environmental attributes by stakeholder group

For the level 2 indicators within the level 1 indicator effect on the environment, with the only exception of academia stakeholders (which assigned an equal weight of 40 for both effect on air pollutants and on resource use), all stakeholder groups assigned higher priority to the effect on air pollutants, as depicted in Figure 10. This was especially true for city authorities, for which the weight assigned for the effects on air pollutants was two times higher than for the effects on resource use, and which found noise to be not important at all.

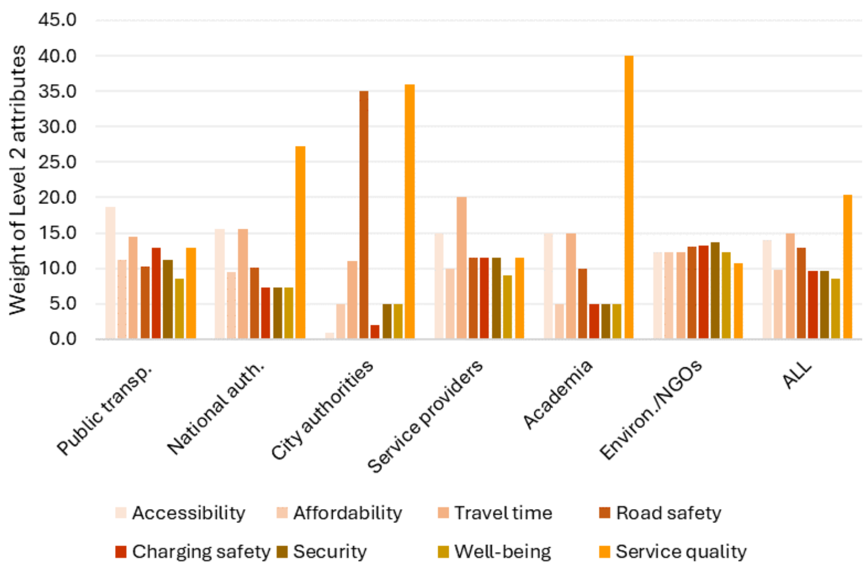

Figure 11: Level 2 weights on societal attributes by stakeholder group

For the level 2 indicators within the level 1 indicator effect on the society, Figure 11 shows a relatively stable pattern (with some minor deviations) can be observed for the stakeholder groups of public transportation authorities, service providers, environmental/NGOs and the overall group (ALL). For these groups, every level 2 indicator received around 10% - 20% of the weight. Academia and national authority groups depicted a clear higher priority assigned to the effects on service quality, while the city authorities group assigned a much higher (and almost equal) priority to the effect on road safety and service quality.

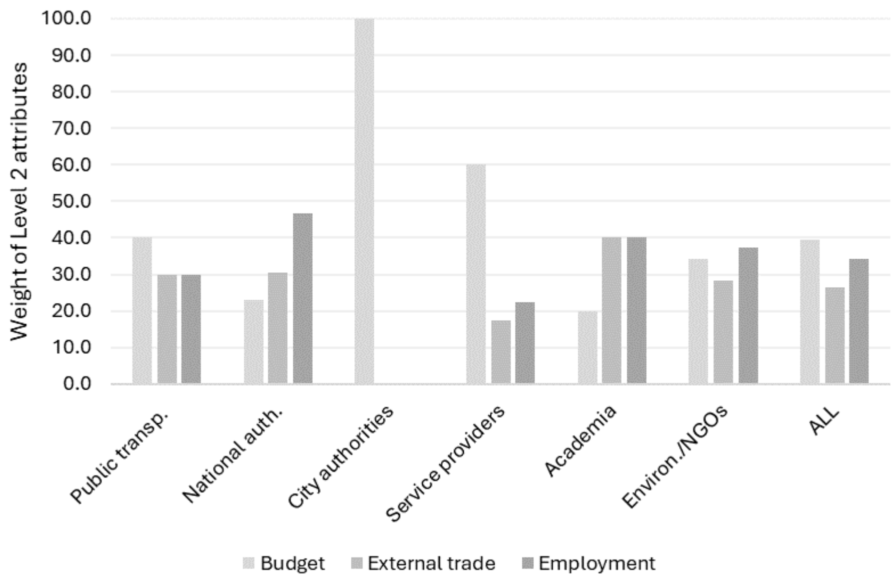

Figure 8: Level 2 weights on project finances by stakeholder group

Regarding the level 2 indicators within the level 1 indicator effect on wider economy, national authorities, environmental/NGOs and academia were the only groups that did not assign the highest priority for the effect on budget, as depicted in . For all other stakeholder groups, the effect on budget was assigned with the highest priority, in which city authorities (100% of the priority assigned to effect on budget) and service providers (60%) depicted a special preference.

2.2 SELECTED INDICATORS FOR ASSESSMENT

This section provides the list of all indicators as well as their classification. The classification attribute determines if the respective indicator was assessed in the ex-ante evaluation (2.2.1), ex-post evaluation (2.2.2) or not assessed (2.2.3). As mentioned in deliverable D1.6 Impact assessment results Volume 1: Overview, the demonstrative character and limited scale of the interventions may render certain aspects of the demonstration project's assessment either trivial or impossible. Indicators that do not have an accompanying assessment are included in this latter category.

2.2.1 Indicators assessed in the ex-ante evaluation

The following indicators were assessed in the ex-ante evaluation of the demo project.

Table 3: Overview of indicators assessed in the ex-ante evaluation of the demo project.

KPI - LEVEL 1	KPI - LEVEL 2	KPI - LEVEL 3
Financial costs/revenues	Financial viability	NPV (Net Present Value)
Financial costs/revenues	Financial viability	IRR (Internal Rate of Return)
Financial costs/revenues	Financial viability	Payback period
Financial costs/revenues	Availability of financial resources	Ease of raising external funding
Institutional/ political	Coherence with national plans and development goals	N/A
Institutional/ political	Alignment with supra-national/national/city legislation & regulations	N/A
Institutional/ political	Ease of implementation (in terms of administrative barriers)	N/A
Climate related	Impact on GHG emissions	Amount of carbon avoided (% change compared to baseline)
Environmental	Impact on air pollutants	NOx emissions avoided
Environmental	Impact on air pollutants	PM2.5 emissions avoided
Social	Impact on accessibility	Access to jobs, opportunities and services (personal travel)
Social	Affordability of e-vehicle services	N/A
Social	Impact on travel time	Change in travel times due to e-mobility services (personal travel)
Social	Impact on road safety	(Annual) Number of road accidents with fatalities/serious injuries
Social	Impact on road safety	(Annual) Number of road accidents with minor injuries/ material damage
Social	Impact on road safety	(Annual) Number of traffic related near accidents/dangerous situations
Social	Impact on charging safety	(Annual) Number of charging related safety incidents
Social	Impact on security	(Annual) Number of vandalism/ theft incidents

2.2.2 Indicators assessed in the ex-post evaluation

The following indicators were assessed in the ex-post evaluation of the demo project.

Table 4: Overview of indicators assessed in the ex-ante evaluation of the demo project.

KPI - LEVEL 1	KPI - LEVEL 2	KPI - LEVEL 3
Environmental	Impact on noise	Perception of the impact of the demo EVs on noise level
Social	Quality of e-mobility services	Suitability of e-vehicles in changing climate conditions [Likert scale]
Social	Quality of e-mobility services	User perception of comfort of e-vehicles [Likert scale]
Social	Quality of e-mobility services	Ease of driving e-vehicles - other users [Likert scale]
Social	Quality of e-mobility services	Ease of charging the e-vehicle [Likert scale]
Social	Quality of e-mobility services	Perception of safety [Likert scale]
Social	Quality of e-mobility services	Perception of personal security [Likert scale]
Social	Quality of e-mobility services	User perception of continuity of journey chains, incl. modal interchange from/to e-vehicles [Likert]

2.2.3 Indicators not assessed in evaluation of the demo project

The following indicators were considered as not being relevant or feasible to assess for the demonstration project. As a result, they were not incorporated into either the ex-ante or ex-post assessments. For each indicator, a brief explanation of why it was not included is provided.

Table 5: Overview of indicators not assessed in evaluation of the demo project.

KPI - LEVEL 1	KPI - LEVEL 2	KPI - LEVEL 3	JUSTIFICATION
Environmental	Impact on environmental resources	Resources saved due to recycling (kg)	Out of scope as there is insufficient information on recycling of the current and future solution
Social	Impact on accessibility	Access to pickup/delivery locations (freight)	This pilot is about personal mobility
Social	Impact on travel time	Change in travel times due to e-mobility services (freight)	This pilot is about personal mobility
Social	Impact on well-being (physical and mental)	Change in well-being due to changes in active travel	There is no active travel in this pilot

KPI - LEVEL 1	KPI - LEVEL 2	KPI - LEVEL 3	JUSTIFICATION
Social	Quality of e-mobility services	Ease of driving e-vehicles - professional drivers [Likert scale]	No professional drivers involved
Economic	Impact on national/ local budget	Required public investment as % of relevant national/local budget	Pilot has too little impact on local budget
Economic	Impact on external trade	Abated fossil fuel imports as % of total imports	Pilot has too little impact on fuel imports
Economic	Impact on external trade	Abated other imports as % of total imports	Pilot has too little impact on imports
Economic	Impact on employment	Number of additional jobs	Pilot has too little impact on additional jobs
Economic	Impact on employment	Expected increase (%) in the average wage	Pilot has too little impact on wages

2.3 KPI ESTIMATION METHODS AND DATA NEEDS

The methods of estimation and data requirements may differ based on the specific indicators. However, a summary of relevant input data is provided below.

- Interviews with stakeholders from different organisations, as mentioned in section 1.5 Relevant stakeholders and user needs.
- Survey answers provided by different stakeholders, as mentioned in section 1.5 Relevant stakeholders and user needs.
- Policies, legislations and other relevant documents from Vietnam which provide further information on plans and measures on topics related to the demonstration project (e.g., energy plans, transportation policies, environmental strategy, and so on). Such policies or legislations are mentioned, whenever relevant, in the subsections of each indicator.
- News articles and reports focused on Vietnam that provide further information on plans and measures on topics related to the demonstration project (e.g., Nationally Determined Contribution (NDC) of Vietnam towards the achievement of the Paris Agreement).
- Internal financial documents and reports developed in the context of the H2020 SOLUTIONSplus project.
- Survey answers provided by pilot participants, these are used for the ex-post analysis in section 4.

In addition to the above overview of general input data, other sources that are pertinent for computing and reporting specific indicators are further detailed in the respective subsections of each indicator.

3 EX-ANTE ASSESSMENT OF THE SOL+ DEMONSTRATION PROJECT

3.1 FINANCIAL VIABILITY

The financial viability of e-mopeds in Hanoi is assessed using the NPV, IRR and payback period for the fleet of 50 Vinfast Ludo e-mopeds. The calculation is done using the Excel "Financial calculations" tool supplied DTU (Technical University of Denmark, one of the Solutions+ knowledge institute partners), required data is sourced from deliverable 4.1[18] for a rough cost breakdown, the internally reported operation results[19] for the expected number of users and wide range of other sources mentioned in more detail below.

The input of the calculation tool is shown in Table 6, sections that require additional explanation are described below:

- General info: as numbers are provided in a mixed currency (EUR and VND) a conversion to USD is made. For this a conversion rate is retrieved and used throughout the calculation. Furthermore, the fleet of 50 vehicles is assessed as a whole because dividing the operational costs to a number per vehicle is not trivial. The relation between fleet size and personnel costs is unknown and prevents an assessment per vehicle.

- Capital cost: the purchase price is derived from the requested funds for the 50 vehicles and required charging infrastructure, a useful lifetime is derived from research on shared, free-floating, mopeds (3.7 years according to that research). However, that is likely an underestimation as the yearly mileage in that study exceeds the mileage of the demo vehicles significantly. For lack of better estimations, a lifetime of 5 years will be used, to compensate for the lower mileage. The residual value and depreciation schedule are based on an expert opinion.

- Operational profile: although this is an ex-ante assessment, the mopeds are a new mode in Vietnam with little operational information. Therefore, the information from the pilot is used for the expected number of trips per day. In the two most popular months 856 trips were registered, which equals on average 14 trips per day across the whole fleet of 50 mopeds. As these trips can be covered by the whole fleet, the number of charges per day is very low.

- Yearly operating costs: all costs are extrapolated from what was requested for the 6-month pilot. Insurance and maintenance costs were an exception however, their 6-month value is assumed to be the same as for the full year. The personnel cost was requested as a lump sum, so the basic monthly salary is derived from that and the assumed number of staff. Electricity costs are based on the average business tariff for a <6 kV connection[20].

- Yearly revenues: the current pilot offered the mopeds at no fee to the traveller. Therefore, an acceptable rate must be estimated. Rental moped in other countries often use a rate per minute, a similar pricing structure is assumed here. For the rate per minute, the cheapest bus ticket price of 5000 VND is assumed . Together with the average trip duration a price/fare of $1.05 is estimated, which is then transformed to a yearly revenue.

Table 2. Results of KPI Prioritization and Weighting by Stakeholders

Category	Parameter	Value	Units	Comments
General info	USD/EUR conversion	1.100	$/€	Retrieved on 25-12-2023
	USD/VND conversion	0.0000412	$/dong	Retrieved on 25-12-2023
	Number of total vehicles	50	#	This is filled in for this number of vehicles
	Passenger capacity	2	pax	
Propulsion	Battery type	Li-ion		
	Battery size	1.056	kWh	48V, 22 Ah
	Number of batteries	1		
Capital cost	Purchase price	100100.00	USD	For 50 mopeds: mopeds 51600 Euro, charging+infra 39400
	Expected useful life	5	years	Based on research of ITF from 2020[22] on lifetime of shared mopeds, but extended due to lower mileage
	Residual value	0	USD	Unknown, assumed none
	Depreciation schedule	20%		Per year
Operational profile	Route	BRT Van Khe to Aeon Mall		
	Length of trip	2.2	km	Single trip from Van Khe BRT to Aeon Mall Ha Dong
	Duration of trip	5	minutes	Assuming avg. speed of 26 km/h
	Trips/day	14	trips/day	1573 trips in 182 days (Dec '22 - May '23), but 856 in last two months after promotion[19]
	Total distance/day	30.87	km/day	Product of trip length and trips/day
	Operating days/year	365	days/year	
	Charges/day/vehicle	0.01		Range of 75 km, considering distance per day
Yearly operating cost	Total operating cost	84720	USD/year	Sum of insurance, total personnel, electricity, maintenance and other costs.
	* Insurance	4950.00	USD/year	Frequency: once/year, Assuming it's 45% of the 10k euro for insurance,

Category	Parameter	Value	Units	Comments
				maintenance and electricity
	* Number of staff	10	pax	2 operators (1 on each end), 1 sysadmin, 4 vehicle rotation staff, 3 security staff (3 x 8h shifts) at Van Khe
	* Personnel cost	63800	USD/year	Staff costs for 6 months and 29000 euro, assuming it's regardless of fleet size
	* Basic monthly salary	531.67	USD/month	
	* Electricity cost	19.73	USD/year	
	* Energy consumption	0.014	kWh/km	Battery capacity of 1056 Wh divided by range of 75 km
	* Electricity tariff	0.124	USD/kWh	Average of standard, peak and off-peak business tariff in November 2023 for a <6 kV connection
	* Maintenance cost	4950.00	USD/year	Assuming it's 45% of the 10k euro for insurance, maintenance and electricity
	* Other	11000.00	USD/year	Assuming this is the "Others" cost category of 10k euro
Yearly revenues	Total revenues	5361.99	USD/year	Product of trips/day, number of operating days/year and the expected fare/trip.
	Ticket fare/trip	1.05	USD	Fare during pilot was free, but assuming rate per minute is equal to cheapest bus ticket of 5000 VND
Income tax	Income tax rate	20%		[23]

Using this input, with an assumed discount rate of 10% (a value also used by the Kathmandu pilot), yields the result found in Table 7. Due to the low expected number of trips per day no return is expected, which results in a negative payback period and an undefined IRR.

Table 7: NPV, IRR and payback calculation for the pre- and after-tax situation.

Discount rate	10%					
	Y0	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Year	2022	2023	2024	2025	2026	2027
Investment	$ -100,100					
Residual value						$ -
Annual revenues		$ 5,349	$ 5,349	$ 5,349	$ 5,349	$ 5,349
Annual operating & maintenance costs		$ -84,720	$ -84,720	$ -84,720	$ -84,720	$ -84,720
Net pre-tax cash flow	$ -100,100	$ -79,370	$ -79,370	$ -79,370	$ -79,370	$ -79,370
Cumulative pre-tax cash flow	$ -100,100	$ -179,470	$ -258,840	$ -338,211	$ -417,581	$ -496,951
Pre-tax NPV	-400,976					
Pre-tax IRR	N/A					
Pre-tax payback (years)	-1.26					
Depreciation		$ -20,020	$ -20,020	$ -20,020	$ -20,020	$ -20,020
Book value		$ 80,080	$ 60,060	$ 40,040	$ 20,020	$ -
Taxable income		$ -99,390	$ -99,390	$ -99,390	$ -99,390	$ -99,390
Income tax		$ -	$ -	$ -	$ -	$ -
Net after-tax cash flow	$ -100,100	$ -79,370	$ -79,370	$ -79,370	$ -79,370	$ -79,370
Cumulative after-tax cash flow	$ -100,100	$ -179,470	$ -258,840	$ -338,211	$ -417,581	$ -496,951
After-tax NPV	-400,976					
After-tax IRR	N/A					
After-tax payback (years)	-1.26					

An explorative analysis shows that to reach a cumulative pre-tax cash flow of 0 in 2026 (i.e., break-even at the end the useful life) requires 275 trips per day, keeping all other parameters the same. In other words, at least 138 people would need to be interested to go from the BRT station to the Aeon mall and back. With a fleet of 50 vehicles that's almost 6 trips per vehicle, per day. Given the hours of operation (10:00 – 21:00), the short trip duration (5 minutes) and a popular destination (a large shopping mall) that seems achievable, given that there are no favourable alternatives available to the travellers.

3.2 AVAILABILITY OF FINANCIAL RESOURCES

INDICATOR: AVAILABILITY OF FINANCIAL RESOURCES			
EVALUATION ASPECTS		HANOI E-MOBILITY FOR LAST-MILE CONNECTIVITY	
		ASSESSMENT	JUSTIFICATION
A.	Availability of government/regional/city funds for supporting the project	Yes	[1]
B.	Intention of international donors to get involved in funding e-mobility projects of the suggested nature	Yes	[2]
C.	preparedness of commercial banks to support projects concerning e-mobility in the project city through preferential interest rates or other incentives	Yes	[3]
Evaluation	A 5-point scale is used for scoring. The score directly enters the evaluation framework: 1. The answer to all three dimensions (A and B and C) is negative 2. The answer to either A or B is positive, while C is negative 3. The answer to both A and B is positive, while C is negative 4. The answer to both A and B is negative, while C is positive 5. The answer to C and one or both of A and B is positive		
Final Score		5	

NOTES	
[1]	While explicit policy frameworks for addressing EV uptake in Vietnam appears to be missing [1A], there are important steps that have been taken to support electric vehicles in Vietnam: • Decree 10/2022 from March 2022, which exempts the registration fees for battery electric cars for the first three years and sets a 50% reduction for the subsequent two years, when compared to gasoline and diesel cars with the same number of seats [1B] • Decision No. 882/QD-TTg approving the National Action Plan on Green Growth for the period 2021-2030, which addresses, amongst other topics, mobilizing financial resources and promoting investment for green growth, with resources for performing tasks and activities of the Green Growth plan expected to originate from State budget, international assistance, commercial loans and private investment, and other community and social capital [1C] • Law No. 03/2022/QH15, which reduces tax rate on battery-powered electric cars to 1%-3% (depending on the number of seats) from March 1, 2022 to the end of the 28th February 2027 [1D]
[2]	• The United States International Development Finance Corporation (DFC) has signed a letter of interest with electric vehicles maker Vinfast to consider the Vietnamese company's application for a $500 million loan for expansion, which would support the establishment of lithium-ion battery manufacturing facilities in Vietnam [2A] • In November 2023, Chinese vehicle manufacturer Chery Automobile made a deal with Vietnam's Geleximco to build a factory in the northern province of Thai Binh, worth about $800 million. Such factory is expected to manufacture cars for domestic consumption and export, including ICE, plug-in hybrids, and fully electric vehicles. [2B]

NOTES	
[3]	• Be Group signed a cooperative agreement with VinFast and the Cake by VPBank digital bank to encourage the migration from gasoline to electric e-bikes. Consumers are expected to benefit from e-bike purchase loans starting at zero. [3A]

3.3 COHERENCE WITH NATIONAL PLANS AND DEVELOPMENT GOALS

INDICATOR: COHERENCE WITH NATIONAL PLANS AND DEVELOPMENT GOALS			
EVALUATION ASPECTS		HANOI E-MOBILITY FOR LAST-MILE CONNECTIVITY	
		ASSESSMENT	JUSTIFICATION
A.	Alignment with transport policy at national or city level (e.g., National Transport Plan, City Master Plans, etc.)	Yes	[1]
B.	Alignment with energy policy at national level (e.g., Energy Performance / Efficiency Standards, etc.)	Yes	[2]
C.	Alignment with environmental policy at national or city level (e.g., emission standards, waste, and recycling policies, etc.)	Yes	[3]
D.	Alignment with overarching policies at national level (e.g., National Development Plans, Climate Action Plans, NDCs, etc.)	Yes	[4]
Evaluation	A 5-point scale is used for scoring. The score directly enters the evaluation framework: 1. The alignment with categories A, B, C and D is negative 2. The alignment with one of the four categories A, B, C and D is positive but negative with remaining three dimensions 3. The alignment is positive with any two categories (category A, B, C & D) 4. The alignment is positive with any three categories (category A, B, C & D) 5. The alignment is positive with all categories (category A, B, C & D)		
Final Score		5	

NOTES	
[1]	• In September 2021, the masterplan on the road network for the 2021-2030 period, vision to 2050 was approved. The masterplan mentions in its article "VIII. SOLUTIONS FOR PLANNING IMPLEMENTATION" subitem "3. Environmental, scientific and technological solutions" the focus on developing safe, efficient and environmentally friendly road transport. [1A] • On July 2022, the Green Energy Transition Action Program was approved, which states as its general objective "Developing a green transportation system towards the goal of net greenhouse gas emissions to "zero" by 2050" [1B]
[2]	• Same Green Energy Transition Action Program as mentioned in [1B] • In July 2023, the National Energy Masterplan for the period 2021 - 2030, Vision 2050 was approved. The masterplan, amongst other objectives, aims to reduce carbon emissions in order to meet Vietnam's 'net-zero by 2050'. One of the objectives mentioned is to have a proportion of renewable energy in total primary energy of 15 - 20% in 2030 and about 80 - 85% in 2050. [2A]

NOTES	
[3]	• Same Green Energy Transition Action Program as mentioned in [1B] • Same National Energy Masterplan as mentioned in [2A] • In April 2022, the National Environmental Protection Strategy to 2030, vision to 2050 was approved. This national strategy mentions as some of the general goals for 2030 to “contribute to improving capacity to proactively respond to climate change; ensuring environmental security, building and developing circular economy, green economy, and low-carbon models, striving to achieve the country’s 2030 sustainable development goals” and as one of the specific goals for 2030 to “Contribute to improving capacity to adapt to climate change and promote mitigation of greenhouse gas emissions.” [3A]
[4]	• Multiple national level policies address mitigation of GHGs, such as the Green Energy Transition Action Program [1B], National Energy Masterplan [2A], and the National Environmental Protection Strategy [3A] • Vietnam completed the review and update of the NDC in 2020 (NDC 2020) and updated the NDC (NDC 2022) following determinations from COP26. [4A]

3.4 ALIGNMENT WITH SUPRA-NATIONAL/NATIONAL/CITY LEGISLATION & REGULATIONS

INDICATOR: ALIGNMENT WITH SUPRA-NATIONAL/NATIONAL/CITY LEGISLATION & REGULATIONS			
EVALUATION ASPECTS		HANOI E-MOBILITY FOR LAST-MILE CONNECTIVITY	
		ASSESSMENT	JUSTIFICATION
A.	Full compliance: It can be ascertained that the relevant project element/s is/are fully compliant with the regulation	No	
B.	Presence of uncertainty: Situations wherein it cannot be fully ascertained whether the relevant element/s of the proposed project is/are either fully compliant to, or appropriately covered by existing regulations, or in cases where potential significant regulatory hurdles are foreseen (e.g., impending changes in regulations).	Yes	[1]
C.	Non-compliance: It can be ascertained that the relevant project element/s would not comply with the applicable regulation/s.	No	
Evaluation	A score is assigned to the project concept based on the 5-point scale provided below: 1. It is certain that the proposed project would not comply with at least 1 applicable regulation 2. There have been identified at least 3 instances of uncertainties in relation to the compliance of the proposed project with the applicable regulations 3. There have been identified 2 instances of uncertainties in relation to the compliance of the proposed project with the applicable regulations 4. There has been identified 1 instance of uncertainty in relation to the compliance of the proposed project with the applicable regulations 5. The proposed project complies with all applicable regulations identified above		
Final Score		5	

NOTES	
[3]	• Decision No. 876/QD-TTg from July 2022 approving the Action Program for Green Energy Transition and Carbon Dioxide and Methane Emissions Mitigation in Transportation. This legislation mentions, amongst other topics, under roadmap 2022 – 2030 the promotion of the production, assembly, import and conversion of electric road vehicles, the development of electric charging infrastructure to meet the needs of people and businesses and the incentive of new and existing bus stations and rest stops to be converted according to green criteria. From 2031 to 2050, there will be a gradual limitation and eventual elimination of the production, assembly, and import of cars and motorbikes using fossil fuels for domestic use, and by 2050 it is expected that 100% of road motor vehicles and construction motorbikes participating in traffic will convert to using electricity and green energy. The decision also mentions under tasks and solutions the need to build and perfect institutions, policies and planning, such as developing policies to encourage and support people and businesses to convert road vehicles using fossil energy to using electricity and green energy, and planning and constructing electric charging station system [1A] [1B] • In April 2023, the Ministry of Industry and Trade asked for the development and publication of standards and regulations on the design, installation, and operation of electric vehicle charging stations in Vietnam [1C], and by February 2024 the Ministry of Science and Technology announced 11 standards for electric vehicle charging stations which are claimed to have been built on the basis of equivalent standards of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), however, further information on this is still expected to be released. [1D] • Decree No. 08/2022/ND-CP from January 2022 elaborates on several Articles of the Law on Environmental Protection, including topics related to the responsibility for recycling products and packaging of producers and importers. Under its article 77 item 4, it is stated that producers and importers shall fulfil their responsibility for recycling products and packaging they produce/import according to the following roadmap: a) Packaging, batteries, cells; lubricating oil; tires: as of January 01, 2024; b) Electric and electronic products: as of January 01, 2025; c) Vehicles: as of January 01, 2027. [1E] [1F] The sources above address topics that are very relevant for the goals of the project (e.g., decarbonisation plans, charging infrastructure and standards, sustainability and recycling responsibilities, among others). However, these sources often discuss these subjects from a broad perspective, outlining what is required, what changes will occur, and the timeline for these changes, without necessarily detailing how these regulations or policies will be implemented. Consequently, the lack of explicit guidelines on how such legislation or policies might impact the project creates uncertainty about the degree to which the proposed project complies with the relevant regulations.

3.5 EASE OF IMPLEMENTATION (IN TERMS OF ADMINISTRATIVE BARRIERS)

INDICATOR: ALIGNMENT WITH SUPRA-NATIONAL/NATIONAL/CITY LEGISLATION & REGULATIONS			
EVALUATION ASPECTS		HANOI E-MOBILITY FOR LAST-MILE CONNECTIVITY	
		ASSESSMENT	JUSTIFICATION
A.	The project requires administrative interventions of limited scope from the relevant political and institutional bodies, e.g., activities for passing a new law that will make the uptake of an e-mobility solution possible	Unknown	[1]
B.	The political and institutional bodies needed for supporting the	Yes	[2]

INDICATOR: ALIGNMENT WITH SUPRA-NATIONAL/NATIONAL/CITY LEGISLATION & REGULATIONS			
EVALUATION ASPECTS		HANOI E-MOBILITY FOR LAST-MILE CONNECTIVITY	
		ASSESSMENT	JUSTIFICATION
C.	The existing national/city political and institutional bodies are (likely to be) supportive of the necessary actions required for the project implementation	Yes	[3]
Evaluation	A 5-point scale is used for scoring. The score directly enters the evaluation framework: 1. The answer to all three dimensions (A and B and C) is negative 2. The answer to either A or B is positive, while C is negative 3. The answer to both A and B is positive, while C is negative 4. The answer to both A and B is negative, while C is positive 5. The answer to C and one or both of A and B is positive		
Final Score		5	

NOTES	
[1]	A number of important policies or regulations on the national level have been proposed that should positively impact the uptake of electric vehicles, such as the Masterplan on the road network for the 2021-2030 period [1A], the Green Energy Transition Action Program [1B], the National Energy Masterplan for the period 2021 - 2030, Vision 2050 [1C], and the National Environmental Protection Strategy to 2030, vision to 2050 [1D]. All the above policies or regulations address either more or less explicitly the need for higher uptake of electric vehicles. Examples include mentions related to (a) the need to address climate change adaptation and sustainable development; (b) promoting production, assembly, import and conversion of electric road motor vehicle and develop charging infrastructure to meet the needs of people and businesses; (c) the development of electric vehicles in accordance with general trends in the world; and (d) promoting the use of non-motorized and environmentally friendly means of transport (bicycles, electric vehicles, vehicles using clean fuels, renewable energy) and developing and implement a roadmap for conversion and elimination of fossil fuel-powered vehicles and vehicles that pollute the environment. While the policies and regulations do address more sustainable transportation options and thus have a positive impact on e-mobility solutions, it cannot be definitively stated that this entails "administrative interventions of limited scope" to make the uptake of an e-mobility solution possible.
[2]	As mentioned in section 1.5.6, different governmental authorities are directly involved in e-mobility in Vietnam: the Ministry of Planning and Investment (MPI), the Ministry of Finance (MOF), the Ministry of Trade and Industry (MOIT), the Ministry of Transport (MOT), the Ministry of Science and Technology (MOST) and the Ministry of National Resource and Environment (MONRE). These ministries oversee strategic policies in the EV industry and other concerns related to EV deployment such as urban plan development, national energy network, and long-term investment issues.
[3]	All policies or regulations mentioned in Note [1] above ([1A], [1B], [1C], [1D]) demand cooperation among various ministries to execute strategies or measures and monitor and evaluate the implementation process, including the Ministry of Planning and Investment (MPI), the Ministry of Finance (MOF), the Ministry of Trade and Industry (MOIT), the Ministry of Transport (MOT), the Ministry of Science and Technology (MOST) and the Ministry of National Resource and Environment (MONRE). Given the inter-ministerial collaboration, it is anticipated that they would likely be supportive of the necessary actions for the project implementation.

3.6 IMPACT ON GHG EMISSIONS

The first phase of the pilot consists of a trial with 50 shared e-moped to test the sharing system and facilitate traveling from BRT Văn Khê to AEONMall Hà Đông. According to Google Maps, the route is 2.2 km. This route is the only route which is selected for the shared moped system. A single one-way trip by moped is thereby 2.2 km.

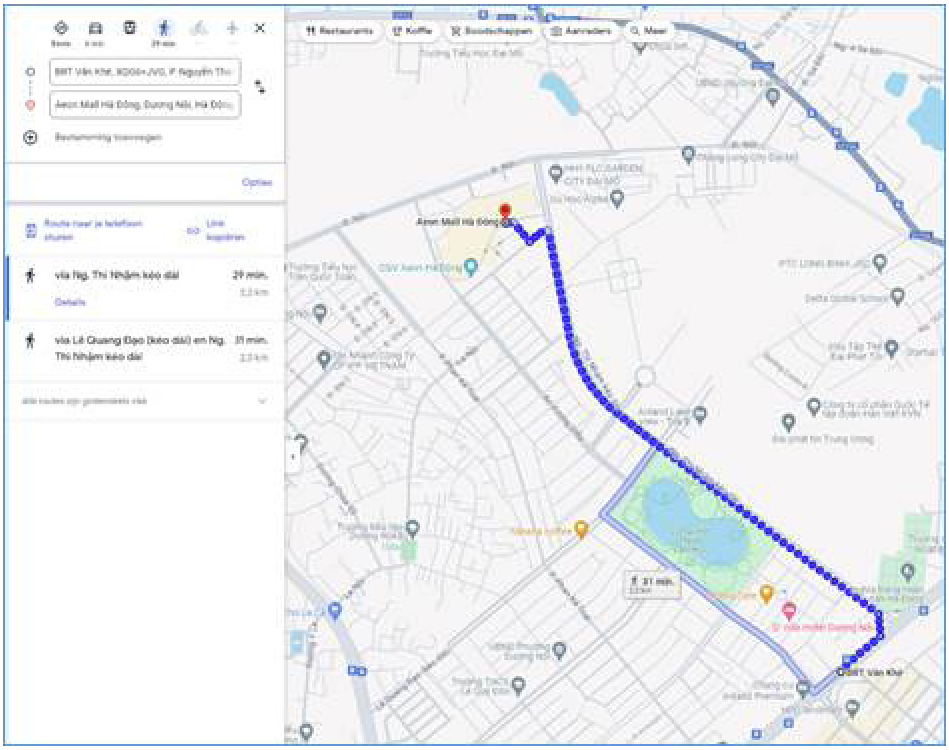

Figure 13: Route of e-mopeds

The AEONMall has a shuttle bus which connects the BRT stop and the mall. The shuttle bus is a 4th generation (1997-2018) Mitsubishi Fuso Rosa, a medium sized bus with a passenger capacity of between 11 and 17 seat[24], given the double hind doors seen on Google Maps (see also Figure 14). While the fourth generation of Fuso Rosa is produced since 1997, it was only introduced in Vietnam in 201[25]. Given the features seen on Figure 14, we estimate that this is a later version of the 4th generation, between circa 2010-2018.

Fuel usage is circa 18 litre diesel per 100 k[26]. Based on the deliverable D1.6 Impact assessment results Volume1 Overview, 2.71 kg of CO2 is emitted from 1 litre of diesel[27], which translates to 487.8 grams of CO2 per vehicle km. These emissions are Tank-to-Wheel (TTW) emissions coming from the combustion of diesel. Well-to-Wheel (WTW) emission include besides TTW also Well-to-Tank (WTT) emissions. For diesel, WTW emissions become 637.6 grams of CO2 per vehicle k[28].

a WTT is 23.5%, TTW is 76.5% for diesel. 487.8 g/km TTW (76.5%) and 637.6 g/km WTW (100%). See also Lijst emissiefactoren | CO2 emissiefactoren

Figure 14: Sighting of AEONMall shuttle on Google Maps Streetview, crossing P.Nguyen Thanh Binh & Ng. Thi Nham keo dai

The e-mopeds are Vinfast Ludo mopeds. Given that the battery is 1.38 kWh and presented range is 90 km, energy usage is 0.0153 kWh per vehicle km. In order to make a sound comparison between the shuttle bus and the e-moped, we need to compare WTW emissions. In 2019, for each kWh of electricity, 521 grams of CO2 are emitted in Vietnam[29]. The emissions-intensity has increased nearly 25% between 2014 and 2019, largely resulting from the ramp up of coal fired power generation. Electric vehicles have no TTW combustion emissions, meaning that WTW emissions from combustion therefore come solely from WTT. Given the energy mix, WTW emissions are 8.0 grams of CO2 per vehicle km for the e-moped (i.e. energy mix of 521 g/kWh and 0.015 kWh/km).

Another important factor to be considered is the average occupancy rate of the vehicles. Passenger km's can be used to make an accurate comparison between transport modes and (potential) substitution effects. If on average 10 passengers travel in the shuttle bus per trip, WTW emissions are circa 64 grams of CO2 per passenger-km (pkm) 64 grams of CO2 per passenger-km (pkm) (i.e. 637.6 g per vehicle km, divided by 10 passengers, results in 64 g per pkm. If the e-mopeds are used by a single person, WTW emissions are 8 grams of CO2 per pkm, eight times lower than the shuttle bus.

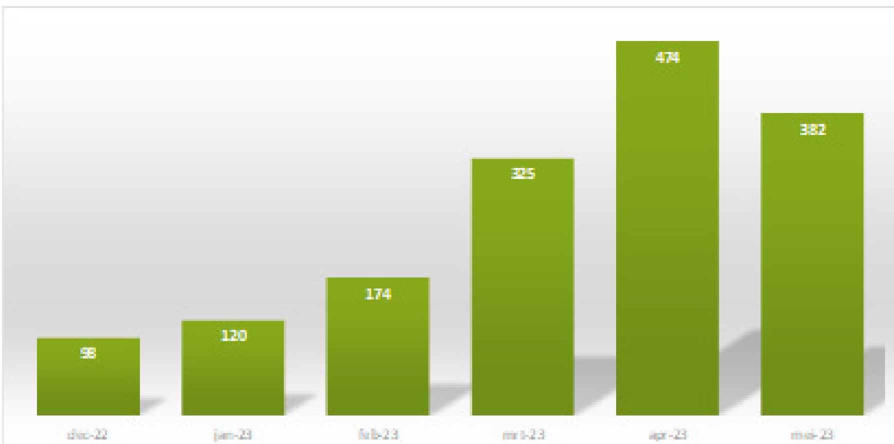

Figure 15: Number of registered trips e-mopeds[19]

During the period between December 2022 and May 2023 there were in total 1,573 rides e-moped rides and an average of 262 rides per month. The potential reduction in CO_2 emissions, coming from pkm driven, are on average 32 kg of CO_2 WTW, and in total 193 kg of CO_2 WTW[b]. This potential can be increased when more e-moped rides are taken instead of shuttle rides.

Given the potential CO_2 reduction by the e-moped rides, it is important to point out the element of transport mode substitution. If shuttle rides are reduced because a certain number of passengers take e-mopeds instead of bus rides, then there is an actual reduction in CO_2 emissions. Without a reduction of shuttle rides (i.e., the shuttle bus schedule remains, and the number of shuttle rides remain the same) the WTW emissions of the e-mopeds will only be added on top of the already existing emissions coming from trips between BRT Văn Khê to AEONMall Hà Đông.

3.7 IMPACT ON AIR POLLUTANTS

Local air pollutants, coming from NOx and particular matter (PM) are emitted from fossil fuel combustion. PM emissions coming from tire and brake wear also occur, though there is not enough data available for this specific situation in Hanoi.

Local air pollutants come from TTW emissions, in this case the use of diesel fuel in the shuttle bus. The e-mopeds do not have TTW emissions, which means the potential avoided air pollutants are those coming from the shuttle bus.

No data is available on the actual shuttle bus used by the AEONMall, though brochures of the particular bus model (late 4th generation Mitsubishi Fuso Rosa, see also section 3.6) state that the emission level is ADR 90/03 – JP05, and emission control is Silicon Carbide DPF and Catalytic Converte[30]. The fifth generation Mitsubishi Fuso Rosa has emission level Japan 17 (exceeds Euro 6 requirements) and diesel particulate filter (DPF) and selective catalytic reduction (SCR)[31]. Since there is no mentioning of SCR in the 4th generation of bus, it is assumed that the only emission control is Exhaust Gas Recirculation (EGR) and catalytic converter.

NOx and PM emission data was not available for this type of shuttle bus, though comparable data is available for larger busses. Given the emission control systems on the 4th generation bus, we could compare the AEONMall shuttle bus with European EURO5 class with EGR. Using CO_2 emissions for urban road types (RT1) as a benchmark, one can see that a large line bus has 1,004 g/km CO_2 emissions in the Netherlands (Emissieregistratie[32]).

Table 8: Air pollution emission data per vehicle km

VEHICLE	CO2 [G/KM]	NOX [G/KM]	PM10 [G/KM]
Autobus EURO5 EGR	1,004	5.8	0.105
Shuttle bus [c]	488	2.8	0.051

b i.e. 262 rides (576 km) and 73 rides (3460 km), times difference (-55.7 g/km) between shuttle bus (63.7 g/km) and moped (8.0 g/km).

c TTW CO_2 emissions are 487.8 g per vehicle km driven. NOx and PM10 emissions are scaled using CO_2 emissions.

$PM_{2.5}$ data was unavailable, therefore PM_{10} emissions are used. We assume that the average occupancy rate of the shuttle bus is 10 passengers per ride (see also section 3.6). NO_x emissions are therefore 0.28 g/pkm and PM10 emissions 5.1 mg/pkm[d]. The potential reduction[e] from 1,573 (3,461 km) e-moped rides between December 2022 and May 2023 are 975 grams of NOx and 17.7 grams of PM10. Similar to what was discussed in section 3.6, without an actual reduction of shuttle bus rides, these reductions remain potential.

3.8 IMPACT ON ACCESSIBILITY

The rental stations where e-mopeds can be picked up and left behind are (more or less) at the same location as the current shuttle bus-stops, no stops will be added or removed. Therefore, no impact on this indicator is expected, in accordance with the D1.6 KPI guidance[33], so the KPI value is 0%.

3.9 AFFORDABILITY OF E-VEHICLE SERVICES

Currently the shuttle is free to users and subsidized by the shopping mall. The pilot also provided the e-mopeds at no cost to the user, but the financial viability KPI (section 3.1) assumed a rate of 0.21 USD (5000 VND) per minute of use for the mopeds. For the current route that would result in a cost of 1.05 USD per trip.

As a change from 0 is not defined in terms of percent changes this KPI cannot be determined quantitively. However, any solution in which the cost is not fully carried by someone else than the user (i.e., as the mall does with the shuttle) will result in a decrease of the affordability.

3.10 IMPACT ON TRAVEL TIME

The moving travel time between the shuttle and the e-moped vehicles can be assumed to be identical (both 5 minutes). What differs between these two modes is the required waiting time.

The shuttle departure times from the BRT Van Khê station to the mall are shown in Figure 16.

d From Table 8, 2.8 g/km NOx and 51 mg/km PM10 per vehicle km, divided by 10 passengers per shuttle ride.
e 3,461 moped km driven, which equates to 3,461 pkm (1 person per moped). Pkm multiplied with 0.28 g/pkm NOx and 5.1 mg/pkm PM_{10}.

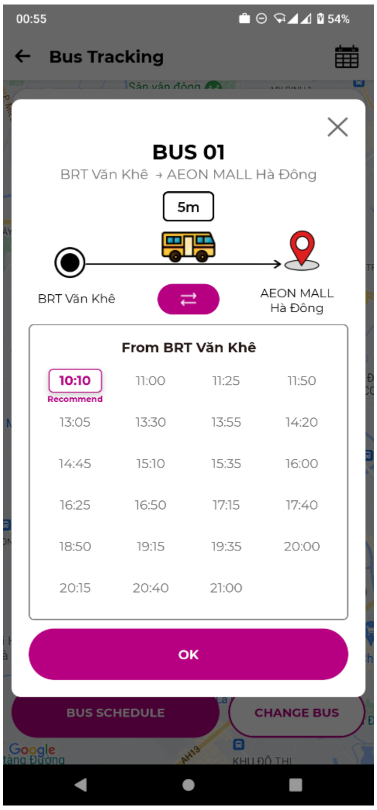

Figure 16: Shuttle bus timetable as displayed in the Aeon Mall app on 19-02-2024

The waiting time for the shuttle bus varies across the day and needs to be approximated. This can be done by assuming a range of desired departure times, e.g., between 10:00 and 21:00 with a 5-minute increment, and then determining how long one would have to wait for each departure time. For example: when a traveller want to depart from the BRT station at 10:15 they must wait 45 minutes for the 11:00 shuttle, departing at 10:20 one must wait 40 minutes, departing at 10:25 one waits 35 minutes, etc. By aggregating these estimated waiting times across the whole day, one finds that it can range from 5 to 70 minutes with an average of 16 minutes.

The e-moped does not have a waiting time (assuming sufficient vehicle availability) and is ready to service the traveller within 5 minutes during which the helmet needs to be retrieved and the e-moped is taken from the stand.

On the arrival side the shuttle traveller can alight the shuttle and continue to the mall immediately, without any extra time required.

The moped user needs to park the vehicle appropriately and hand in the helmet at the security guard, which takes another 5 minutes.

The change in travel time therefore can be found with:

$$\Delta\% = \frac{\left(T_{wait,moped} + T_{travel,moped} + T_{alight,moped}\right) - \left(T_{wait,shuttle} + T_{travel,shuttle} + T_{alight,shuttle}\right)}{\left(T_{wait,shuttle} + T_{travel,shuttle} + T_{alight,shuttle}\right)}$$

Filling in the values deduced earlier one finds an expected reduction in travel time of 29% or on average 6 minutes in absolute terms.

$$\Delta\% = \frac{(5+5+5)-(16+5+0)}{(16+5+0)} = \frac{15-21}{21} \approx -29\%$$

3.11 IMPACT ON ROAD SAFETY

There has been a significant increase in exposure to road traffic injury in Vietnam over the course of the last 20 year[34]. This exposure is made more serious given that two-wheelers, which are the highest risk form of travel on road, comprise about 95% of total motor vehicles in Vietnam and have been steadily increasing at a higher rate than cars. A relatively large share of vehicles in Vietnam is two-wheelers. Historically, Vietnam has one of the highest fatality rates in traffic accidents in the World. Only in 200[35] a compulsory helmet law was introduced, which made helmet use mandatory in Vietnam for all motorcycle drivers and passengers on all roads. Road traffic injury is the second highest cause of death for 5-14 olds in Vietnam, and the highest cause of death and of disability for 15-49 olds.

Official data has shown that fatalities have been steadily decreasing in recent years from a high of 12,800 in 2007 to 8,200 in 2018, with 14,800 injuries in 2018. However, this data is considered by the WHO to be underreported. The 2018 Global Status Report on Road Safety produced by the World Health Organization (WHO) estimated that road fatalities in Vietnam are three times higher than official numbers. Additionally, the World Bank[36] suggests a fatality-to-injury multiplie[37] of 15 to be a reasonable estimate based on countries with good datasets.

Using reported fatalities and injuries suggests that the economic cost of road traffic injury is about US$ 2 Billion. However, taking into consideration the underreporting of the road traffic injuries, the economic costs of road traffic injury in Vietnam could be closer to $18 Billion, a figure which has been recently published in a global review of road safety in low- and middle-income countries by the World Bank[38].

Investigation from 2013 has shown that in Hanoi and Ho Chi Minh City people use motorbikes about 2-4 times daily for an average of about 20-30 km/day and 7,250 to 8,700 km/yea[39]. If we make the assumption of 8,000 km per year per moped, and over 58 million mopeds in 201[40], total distance driven by mopeds in Vietnam is 464 billion km per year. With 8,200 fatalities in 2018, it means an average of one fatality per 58.6 million moped km driven. With 14.800 injuries, this means an average of one injury per 31.4 million km. Using WHO assumptions, this could be one fatality per 18.8 and one injury[f] per 1.3 million km.

Table 9: Average fatality and injury in traffic accidents mopeds

TOTAL KM COVERED PER YEAR	464 BILLION KM
Average fatality	Between 1/(58.6 Million km) and 1/(18.8 Million km)
Average injury	Between 1/(31.4 Million km) and 1/(1.3 Million km)

f Using 15 injuries per 1 fatality from road accidents. From World Bank. 2019. Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Countries Country Profiles. Washington DC, USA: World Bank.

A study on mode choice scenarios in major Vietnamese cities shows that traffic safety is theoretically improved, as improving public transport facilities and reducing the use of motorcycles leads to fewer traffic fatalitie[41]. Given the relatively high number of accidents with two-wheelers in Vietnam, it is likely that traffic safety will decrease with an increase in two-wheeler km's. The pilot includes 1,573 rides equalling 3,461 km by mopeds. This total distance is relatively low, and statistically will not have a major influence on traffic safety.

3.12 IMPACT ON CHARGING SAFETY

According to the International Council on Clean Transportation (ICCT)[42], the sale of electric mopeds in Vietnam is increasing rapidly. However, the moped charging network and battery swapping network is still limited in Vietnam. In order to accommodate the increase in electrification, charging infrastructure needs to be further constructed.
Among the electric moped manufacturers in Vietnam, Vinfast is the leader in providing charging infrastructure and battery swapping services. When charging stations are planned, Vinfast is responsible for installing, maintaining, and repairing the infrastructure. The locations are provided by the partner and the operation of the charging system. Battery swapping locations are also provided by Vinfast, according to ICCT (2022).

Still according to ICCT, technical regulations and standards related to electric moped charging infrastructures and battery swapping services are still unavailable in Vietnam. There appears to be large gaps in the technical regulations and technical standards that apply across the life cycle of electric two-wheelers. ICCT states technical regulations and standards related to charging infrastructure, battery swapping systems, vehicle disposal and recycling of expired batteries are still lacking.

In contrast to mopeds, charging stations for electric vehicles (cars) are subject to the Vietnam appraisal of fire safety designs for some situations. For electric vehicle charging stations located indoors (independent garages, indoor garage of construction projects) or outdoors in case within premises of gas station, the investor requesting approval is the owner of the project[43]. It is within the list of projects, works and motor vehicles list which require appraisal of fire safety design in decree 136/2020/ND-C[44]. For other locations there is no need for appraisal. Several requirements are listed from this source for preventing fire and fire spread, smoke accumulation, fire protection, including water sprinkler systems and supporting systems cutting power in case of spraying water.

The exact effect on charging safety of an increase in e-mopeds in the pilot is complex to answer. On the one hand, Vinfast does already offer services in which charging infrastructure and/or battery swapping can be installed. On the other hand, there is a lack of dedicated standards towards e-mopeds, though there are decrees on electric cars. We assume that, given the added charging of batteries, there will be a higher charging risk, though this is partly mitigated from services the supplier already provides.

3.13 IMPACT ON SECURITY

The likelihood of electric motorcycles being stolen in Vietnam is anticipated to be equivalent to, or possibly greater than, the theft risk for conventional motorcycles. This is especially true if the stolen electric motorcycles can be sold or disassembled for parts at a higher profit than regular motorcycles. To quantify the anticipated impacts for the demonstration project, data on reported motorcycle thefts is needed. Ideally, information on the total number of motorcycles registered in Vietnam would also be available to compute relative figures.

Information on the total number of motorcycles registered in Vietnam was sourced from ASEANstats. However, no reliable or official data on the total number of motorcycle thefts in Vietnam was found. Although motorbike theft is very common in Vietnam, a very limited number of cases are reported to the poli[45] . As a result, in the absence of specific data for Vietnam, benchmark data from other countries is used. The data from Thailand and Laos are the closest estimates to the reality of Vietnam due to geographical proximity, and their figures are very similar as well. Therefore, an estimate of 0.08% of the total motorcycle stock being stolen annually was used (based on Thailand and Laos estimates). Given that the demonstration project involves 50 mopeds, less than one moped (0.04) is expected to be stolen each year, rendering the effect negligible.

Table 10 provides yearly number of registered motorcycles and yearly number of stolen motorcycles from Vietnam and other benchmark countries (some countries are included for comparative purposes only).

Table 9: Average fatality and injury in traffic accidents mopeds

COUNTRY	NUMBER OF REGISTERED MOTORCYCLES	REFERENCE YEAR	SOURCE
USA	9,890,000	2021	[1]
Netherlands	717,600	2022	[2]
Laos	2,299,120	2022	[3]
Thailand	20,327,760	2014	[4]
Vietnam	72,061,320	2020	[5]

COUNTRY	NUMBER OF MOTORCYCLES STOLEN PER YEAR	REFERENCE YEAR	SOURCE
USA	51,291	2021	[1]
Netherlands	1,694	2022	[2]
Laos	1,758	2022	[3]
Thailand	15,269	2014	[4]

COUNTRY	% MOTORCYCLES STOLEN (AS SHARE OF MO-TORCYCLE STOCK)	REFERENCE YEAR	SOURCE
USA	0.519%	2021	[1]
Netherlands	0.236%	2022	[2]
Laos	0.076%	2022	[3]
Thailand	0.075%	2014	[4]

NOTES	
[1]	• Number of motorcycles registered in the U.S obtained from Statista [1A] • Number of Number of reported motorcycle thefts in the United States obtained from Statista [1B]
[2]	• Number of motorcycles registered in the Netherlands obtained from Statista [2A] • Number of Number of reported motorcycle thefts in the Netherlands obtained from Statista [2B]
[3]	• Number of motorcycles registered in Laos obtained from ASEANstats [3A] • Number of Number of reported motorcycle thefts in Laos obtained from Radio Free Asia (RFA) [3B]
[4]	• Number of motorcycles registered in Thailand obtained from ASEANstats [4A] • Number of Number of reported motorcycle thefts in Thailand estimated following the next steps: - The estimated number of 2000 motorcycle thefts per year in 2014 Bangkok was obtained from The Nation Thailand [4B] - The population figures for Bangkok [4C] and Thailand [4D] in 2014 were obtained from Macrotrends. - The share of total population of Thailand living in Bangkok was computed and used to scale-up the total number of motorcycle thefts in the whole country. - Based on the estimated number of motorcycle thefts in the whole Thailand, the % Motorcycles stolen (as share of motorcycle stock) was computed for Thailand
[5]	• Number of motorcycles registered in Vietnam obtained from ASEANstats [5A]

18 https://www.solutionsplus.eu/_files/ugd/de12cd_88767630c1684af69e6ac2fd0f6a051d.pdf
19 https://uemiorg.sharepoint.com/sites/SOLUTIONSplus979/Shared%20Documents/WP4%20Demos%5CAsia%5CHanoi%5COPERATION%20RESULTS%20REPORT%20-%20HANOI%20DEMO.pptx
20 https://en.evn.com.vn/d6/news/RETAIL-ELECTRICITY-TARIFF-9-28-252.aspx
21 https://www.vietnamtourism.org.vn/transportation/bus/hanoi-bus/
22 https://www.itf-oecd.org/sites/default/files/docs/environmental-performance-new-mobility.pdf
23 https://www.vietnam-briefing.com/doing-business-guide/vietnam/taxation-and-accounting#corporateincometaxinvietnamHeader
24 Rosa | Mitsubishi Fuso Truck and Bus Corporation (mitsubishi-fuso.com)
25 "ROSA" Makes Entry to Light Bus Market in Vietnam | Mitsubishi Fuso Truck and Bus Corporation (mitsubishi-fuso.com), Mercedes-Benz's ROSA buses well received in Vietnam | Business | Vietnam+ (VietnamPlus)
26 The Mitsubishi Fuso Rosa | Everything Fleet | Australia, A new test proves that the Mitsubishi Fuso is more efficient than the Isuzu NPR-HD (topspeed.com), Kenteken Check VD-090-K - MITSUBISHI FUSO CANTER 3C13 (autoweek.nl)
27 EFDB - Main Page (iges.or.jp)
28 Lijst emissiefactoren | CO2 emissiefactoren
29 Vietnam-CP2020.pdf (climate-transparency.org)
30 Fuso Rosa Product Brochure.indd (cjd.com.au)
31 FUSO21_ROSA_Custom_Bus_Spec_Sheet_6.0_LR_0.pdf
32 Geilenkirchen et al. (2023) Methods for calculating the emissions of transport in NL_tables_def.xlsx (live.com)
33 D1.6 Impact assessment results Volume 1: Overview (2024), appendix B5.1
34 Vietnam's road accident-related deaths fall by 43.5% in 2011-2020 | Society | Vietnam+ (VietnamPlus)
35 Vietnam's Comprehensive Helmet Law (cgdev.org)
36 World Bank. 2019. Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Countries Country Profiles. Washington DC, USA: World Bank.
37 McMahon, K and S Dahdah. 2016. The True Cost of Road Crashes, Valuing Life and the Cost of a Serious Injury. London: iRAP.
38 World Bank. 2019. Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Countries Country Profiles. Washington DC, USA: World Bank.
39 Vietnam Emission_Control_Scheme_for_Motorbikes.pdf (unescap.org)
40 ldv-asia-using-policy-and-regulation-to-pave-way-for-two-wheeler-electrification-in-vietnam-mar22.pdf (theicct.org)
41 An Minh Ngoc, Hiroaki Nishiuchi, Nguyen Van Truong, Le Thu Huyen (2021): A comparative study on travel mode share, emission, and safety in five Vietnamese Cities
42 asia-pacific-lvs-NDC-TIA-E2W-mkt-growth-Vietnam-nov22.pdf (theicct.org)
43 What are the instructions for fire prevention and fighting for charging stations and chargers for electric vehicles in Vietnam? (lawnet.vn)
44 Decree No. 136/2020/ND-CP dated November 24, 2020 on providing guidelines for a number of Articles of Law on Fire Prevention and Fighting and Law on Amendments to Law on Fire Prevention and Fighting - LawNet
45 Source: https://www.alsok.com.vn/column/solutions-to-motorcycle-theft-one-of-the-security-problems-that-happens-in-vietnam/

4 EX-POST ASSESSMENT OF THE SOL+ DEMONSTRATION PROJECT

The main source of information for the ex-post assessment is the survey that was carried out during the pilot. Respondents were recruited from the e-moped users after they made a trip. The data was collected by UTT and has received 150 responses during the pilot runtime from November 28, 2022 to May 28, 2023. Almost half of respondents was a student or pupil and 40% fell within the 22-35 age category, no strong changes in age or occupation were observed during the pilot.

The high student rate is surprising at first, but when inspecting the map, it is visible that two (international) schools are available in the vicinity of the Aeon Mall (see Figure 17). It could be possible that students used the mopeds as part of their commute.

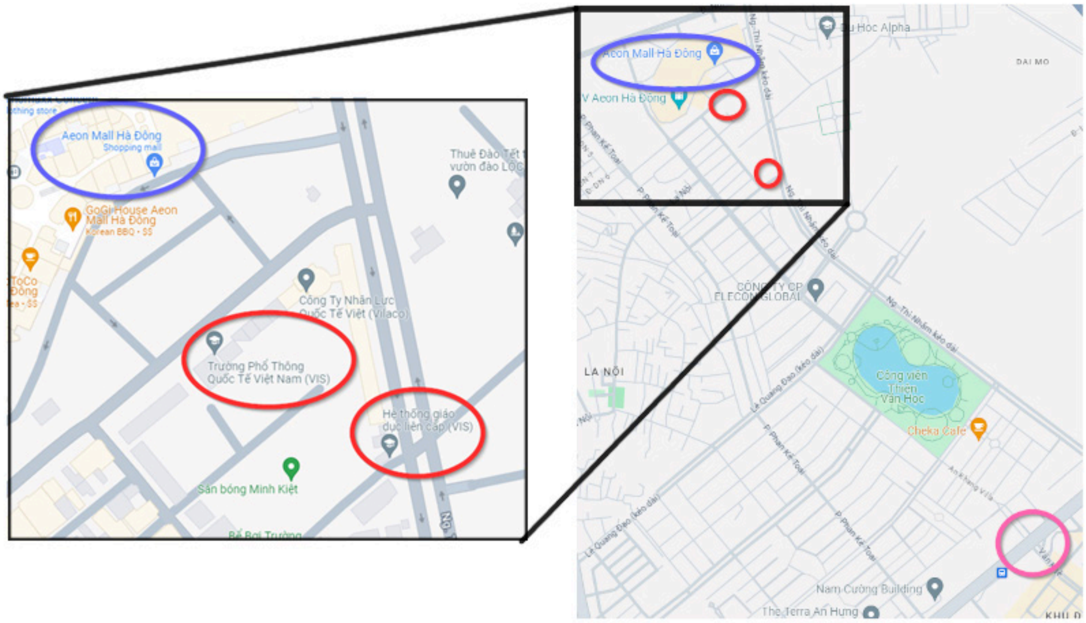

Figure 17: International schools (red) close to the mall (blue). The BRT station is shown in pink on the lower right.

A third of the respondents indicated that they used the service 3-4 times / week, with a quarter of respondents using the mopeds almost daily. Even though one end of the e-moped service was at the BRT station, the majority of respondents (68%) indicated that they did not use the e-mopeds in conjunction with public transport in the same journey.

Figure 18 to Figure 21 show the distribution of respondent characteristics in more detail.

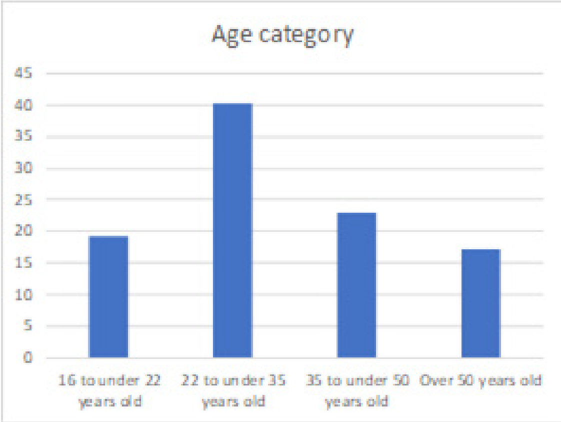

Figure 18: Distribution of age among the respondents of the survey.

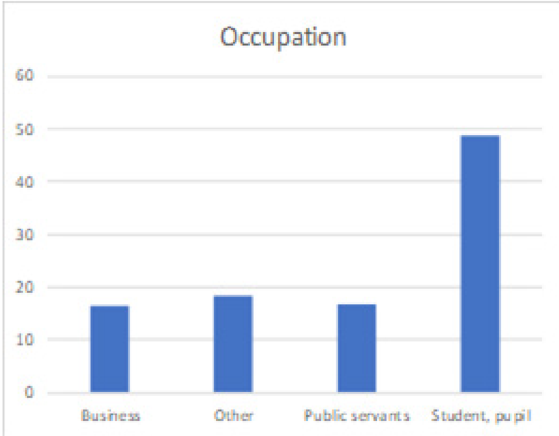

Figure 19: Distribution of occupation among the respondents of the survey.

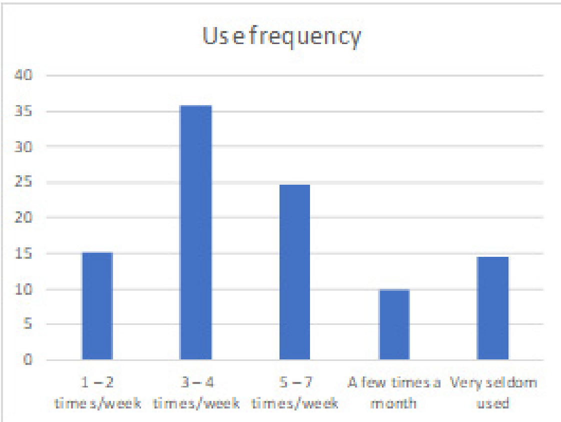

Figure 20: Stated use frequency of the e-mopeds

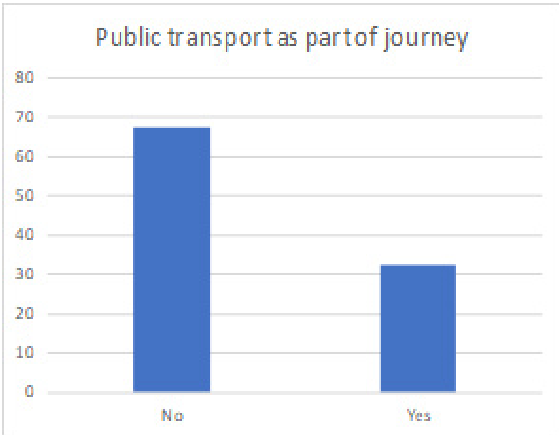

Figure 21: Indication if respondents used public transport in addition to the e-moped service on the same journey

4.1 IMPACT ON NOISE

The impact of the e-moped service on the experienced noise level is measured in the survey with the question: "please provide your opinion on the noise level, comparing the e-moped trip with the trip when this service was not available", the latter part refers to the situation when travellers could only use the shuttle (or walk). Respondents could either indicate the noise level was worse, the same or better than before. An overwhelming majority (98-100%, dependent on the month) indicated that the noise level was better than before, i.e., it was quieter. Given that a change in sound level of +/- 3 dB appears as a perceptible change in loudnes[46] and the large proportion of respondents that answered the e-mopeds were quieter, this result is marked with the score "5. significantly quieter".

It should be noted that e-moped drivers and passengers are required to wear a helmet, this dampens the sound and can influence the experienced loudness.
Objective evaluations through sound pressure level measurements have not been carried out in the pilot.

4.2 QUALITY OF E-MOBILITY SERVICES

The quality of the offered e-mopeds is assessed in the survey on the experienced safety and service quality, in comparison to the situation without e-mopeds and with a shuttle only. The respondents rated the different topics on a Likert scale from negative (1) to positive (5), resulting in Figure 22. Per topic a score is calculated by averaging the Likert ratings, this score feeds into the assessment.

For convenience the scores are listed below per topic:

- Suitability for adverse weather: 3.2
- Perceived comfort: 4.9
- Perceived drivability: 4.9
- Perceived ease of renting and returning vehicle: 4.5
- Perceived safety: 3.9 (average of 3 safety scores)
- Perceived continuity of journey chain: 4.4

Overall the new solution is experienced more favourably than the old one (i.e. shuttle or walk), only the safety aspects and weather suitability were rated by some respondents as less favourable than the old solution.

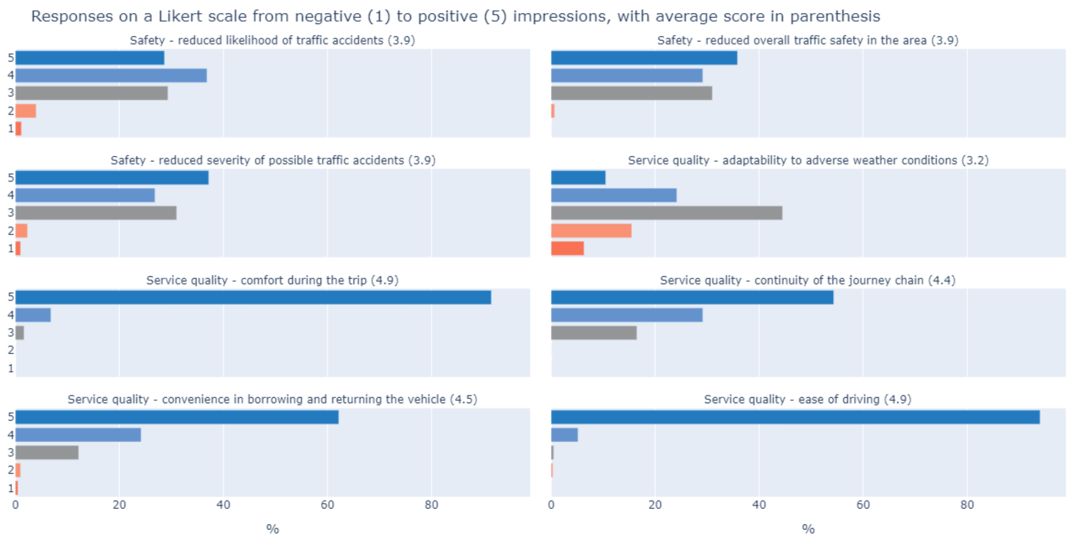

Figure 22: Survey response related to the quality of e-mobility services.

46 https://www.ussi.com/acoustical-rules-and-demystifying-decibel.php

5 BASELINE SCENARIO

In this section a subset of KPI's is determined for the case that no Solutions+ project would exist and that shuttle buses are not replaced (partially) by e-mopeds.

To aid in this assessment UNEP provides the eMob calculator[47] which can estimate the value of KPI's for the baseline and scaled-up scenario for a specific mode. However, the current pilot involves a mode shift from shuttle to e-moped, a situation that is not supported by the tool. Therefore the choice is made to not use the eMob tool, but determine the KPI's separately.

5.1 VEHICLE STOCK

In the baseline scenario, the number of motorcycles and buses are expected to change in a do-nothing scenario, in which no expansion of the mopeds demo project takes place. Figure 23 presents projections from the World Bank of road vehicle numbers for different vehicle types in Vietnam, while Figure 24 and Figure 25 present the evolution of the bus and motorcycle stocks using data from ASEANstats. The report by the World Back estimated that that the number of motorcycles will not continuously grow, but instead reach a plateau. However, given the numbers provided by ASEANstats, it is likely that a plateau, if reached, happens at much higher levels than originally estimated by the World Bank, given that by 2020 the number of registered motorcycles was much higher than forecasted.

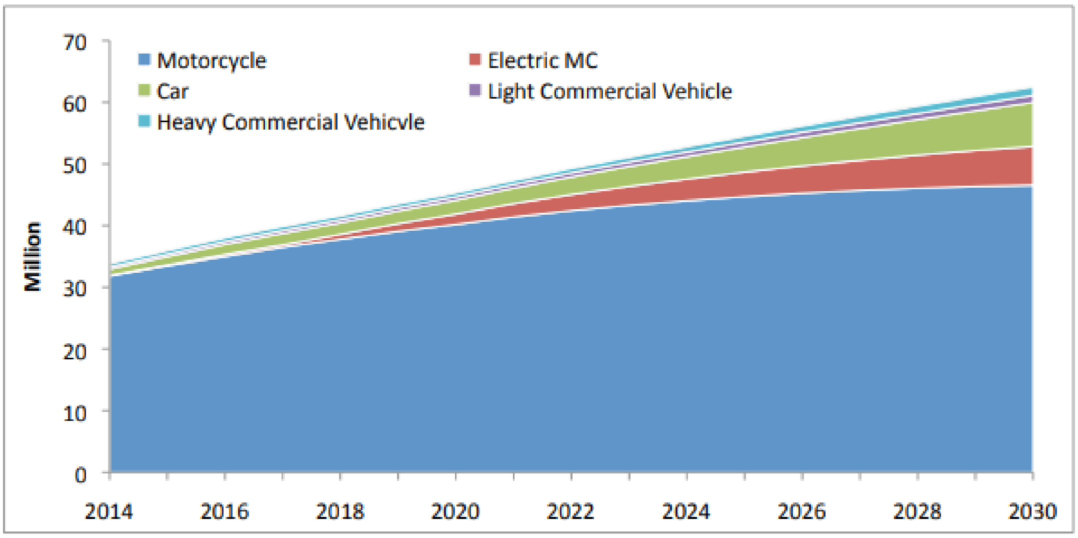

Figure 23: Projections of Road Vehicle Fleet Numbers by Vehicle Type (source: World Bank Group)

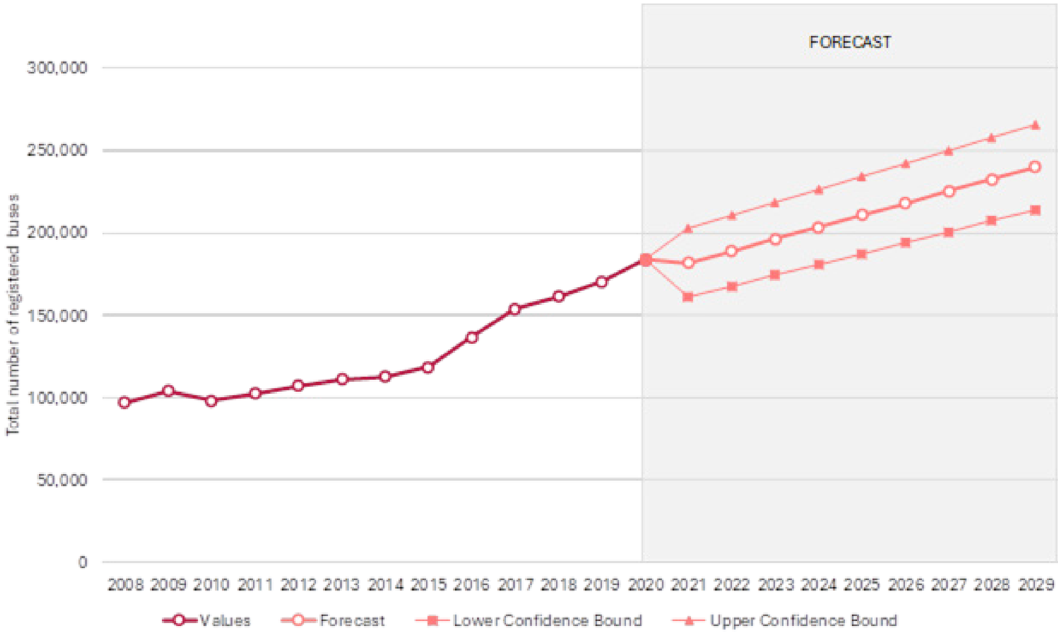

Figure 24 Evolution of the bus stock in Vietnam (source: ASEANStatsDataPortal)

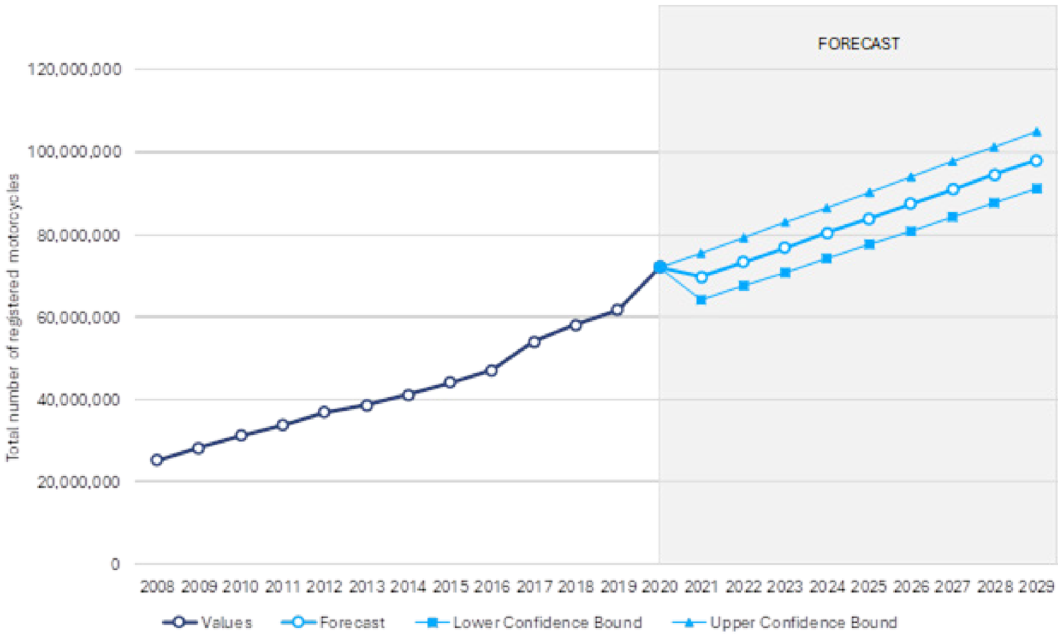

Figure 25 Evolution of the motorcycle stock in Vietnam (source: ASEANStatsDataPortal)

5.2 IMPACT ON GHG EMISSIONS

The transport sector is becoming a large and growing contributor to total greenhouse gas (GHG) emissions in Vietnam, accounting for 18% of total CO2 emissions in 2014, according to the World Bank Group[48]. More recent data seems to be unavailabl[49]. The World Bank Group uses a business as usual (BAU) scenario which projects future emissions without interventions. It starts with a reported 33.2 Mtons of CO2 coming from transport in 2014. In this scenario it increases to 47.7 in 2020, 65.1 in 2025 and 89.1 in 2030 (see also Figure 26). It is unclear if this is factoring in WTT emissions, and therefore if these numbers are TTW or WTW.

Another source coming from 2024[50], stating a forecast of the Transport Development and Strategy Institute (TDSI) of Vietnam, mentions 64.3 Mtons in 2025 and 88.1 Mtons in 2030.

Research from Ngoc et al. (2022) states 3.9 Mtons of WTW CO2 emissions in 2014 in Hanoi, with 58% coming from motorcycles.

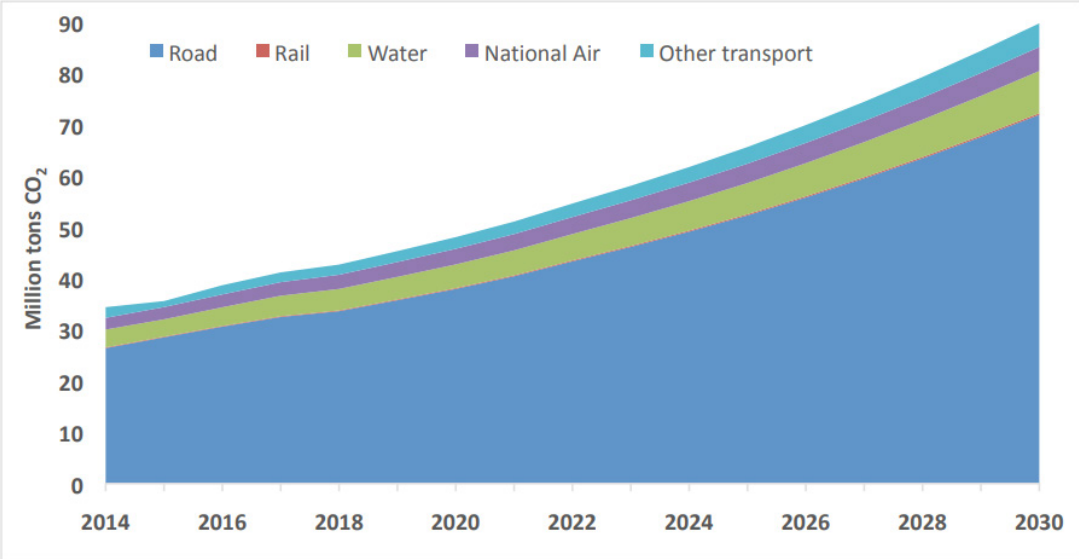

Figure 26: CO2 emissions projection by transport subsectors in a BAU scenario (source: World Bank Group)

Important to note is the amount of two-wheelers in the BAU scenario. These seem to plateau after 2028 towards a lower number than is the case in the projection, and even more recent 2020 numbers of two-wheelers, in 5.1. Also electric vehicles compose 2.5% of the vehicle fleet in 2030 according to the BAU scenario in 2030. According to ICCT, electric moped market share was reaching 10% in new sales in 2021. Although the total number of e-mopeds is stated, there is reason to assume (given the high amount of two-wheelers) that in 2030 the number of electric vehicles is higher than 2.5%.

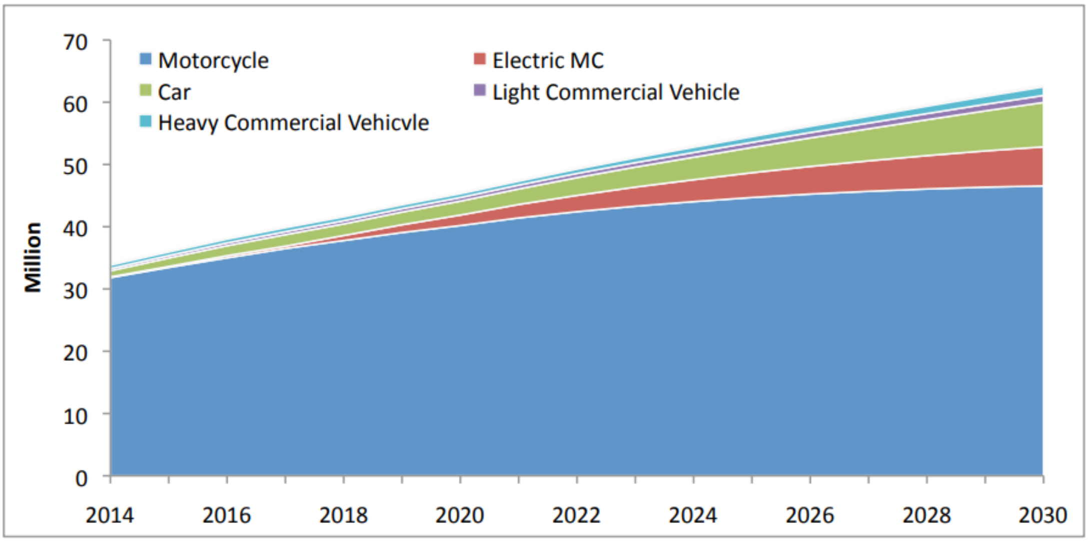

Figure 27: Projections of road vehicles by type in a BAU scenario (source: World Bank Group)

Decree 06/2022/ND-C[51] aims at the regulation on GHG mitigation and protection of the ozone layer, with a transport sector target that reaches a minimum of 37.5 Mtonnes of CO2eq.

It seems that there is a lack of data on recent CO2 emissions. Therefore, it is difficult to say what a future (baseline) projection of CO2 emissions could look like. Most sources project an increase in emissions towards 2030.

5.3 IMPACT ON AIR POLLUTANTS

Data from the World Bank[52] presents that total nitrous oxide emissions in 2020 are 26.8 Mtons of CO2eq. There are some policy decisions in place to combat the emissions of methane in Vietnam (No. 942/QD-TTg), with the goal to limit total methane emissions to 94.4 in 2025 and 77.9 Mtons of CO2eq in 2030. There seems to be a discrepancy in the total amount of NOx emissions.

Amann et al. (2018)[53] state that measure annual mean concentrations of PM2.5 are above national ambient air quality standards and exceed global guidelines of the WHO by a wide margin. In this analysis, it is stated that despite adopted policy measures air quality could further deteriorate in the future, resulting in PM2.5 emissions in 2030 are 25-30% higher than in 2015, causing 85% of the population in northern Vietnam exposed to levels of PM emissions above the national ambient air quality standard. In contrast, transportation makes the largest contributions (>70%) to NOx emissions in Hanoi, while emissions from transport represent 25% of total PM2.5 in Hanoi province. In Hanoi in 2015, it is estimated that 66.6 Ktons of NOx and 23.5 Ktons of PM2.5 are emitted in total.

5.4 IMPACT ON ACCESSIBILITY

With an increase in expected bus stock (see Figure 24) the accessibility is also expected to increase as the public transport network grows and more destinations become available[54]. Even without more available destinations, the extra buses will lead to more frequent service, less waiting time and ultimately to better accessibility.

5.5 IMPACT ON TRAVEL TIME

As described in the ex-ante assessment (section 3.10) the travel time consists of several parts. Assuming that in the baseline, shuttle routes similar to the demo site are considered, the values for these travel time parts are as follows:

- the actual time required to move from A to B: 5 minutes;
- the waiting time for the vehicle to become available: between 5 and 70 minutes, average of 16 minutes;
- the board/alight times: 0 minutes

On average a travel time of 5 + 16 = 21 minutes is expected in the baseline.

5.6 IMPACT ON ROAD SAFETY

Over the past years, road accidents related deaths have fallen significantly in the period 2011 to 2020[55]. According to decision 2060/QĐ-TTg 2060, Vietnam wants to continue this trend in the coming years, annually reducing 5 to 10% of road traffic deaths and injuries[56]. National targets focus on technical safety standards (95% in 2025, 100% in 2030), education on road safety regulations and first aid education for drivers for traffic accident victims, and special focus for safety for children in traffic[57].

Using the 5 and 10% reduction range and traffic fatality data[58], Figure 28 shows a projection of what would happen if this reduction continues after 2022. Important to note is that WHO mentions fatality data could be three times higher than reported from estimations (3.11).

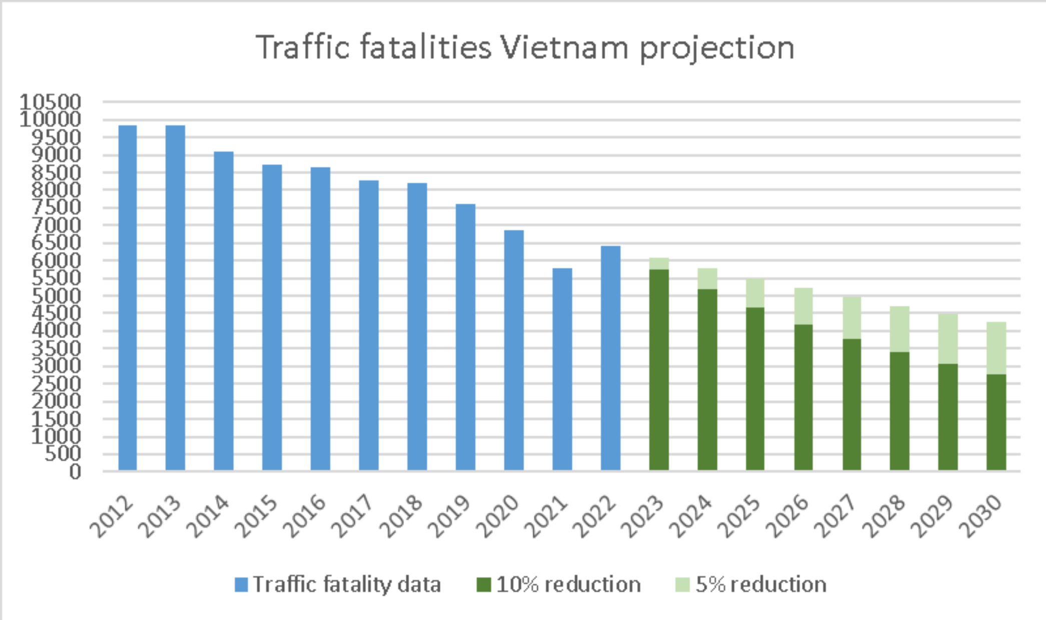

Figure 28: Projection of traffic fatalities, based on Vietnam traffic safety goals

5.7 IMPACT ON SECURITY

The baseline scenario considering the impact on security uses the same indicator evaluated for the ex-ante assessment (annual number of theft incidents) and the same percentage of motorcycles stolen (as share of the motorcycle stock) calculated in the ex-ante analysis (expected to be of 0.08%). The difference refers to the fact that in the baseline scenario, no additional motorcycles are added to the yearly stock due to the scaled-up project, and therefore only the average annual increase (derived from ASEANStatsDataPortal) is used. The expected number of stolen motorcycles per year (2020 – 2029) and per scenario (baseline and scaled-up project) is reported in the ex-post section 1.6.14 Impact on security.

5.8 IMPACT ON NOISE

A study from 2010[59] characterized the road traffic noise in Hanoi and measured both the sound and the traffic intensity in various locations across the city. Interestingly, as can be seen in Figure 29 and Figure 30 there does not seem to be a strong correlation between traffic intensities and noise levels. Surely at night the noise level is lower (when there is almost no traffic), but during the day, the peak hour pattern is not seen in the noise level.

So while the vehicle stock, and consequently the traffic volume, is expected to increase (Figure 24 and Figure 25), this does not mean that noise levels will increase proportionally.

The same study does indicate that vehicle horns have a non-negligible effect on the total noise level. Assuming that horn usage is uniformly distributed, the growing vehicle stock is likely to result in more horns being used and a higher noise level.

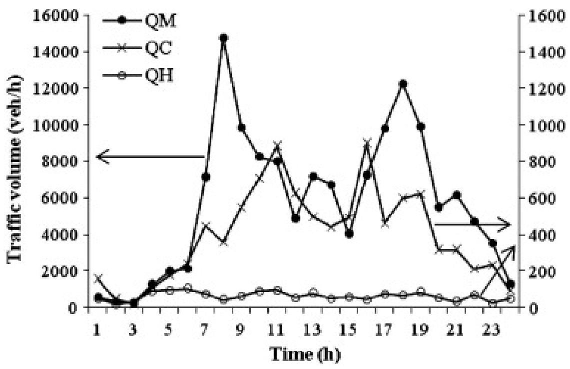

Figure 29: Hourly traffic volume data from Site 2 in Hanoi.59. QM, QC and QH indicate traffic flow or motorcycles, cars, and heavy traffic respectively.

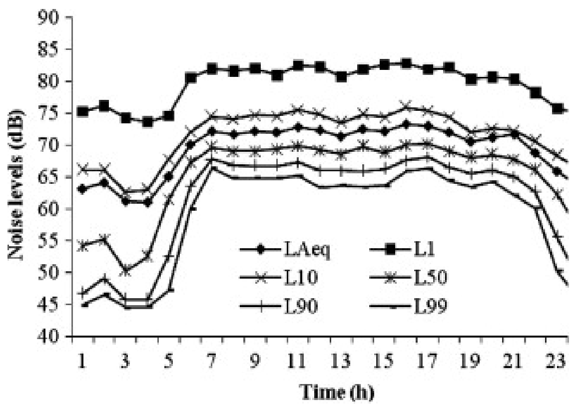

Figure 30: Hourly noise levels of Site 2 in Hanoi59. Showing A-weighted sound level LAeq and several percentile sound levels.

5.9 IMPACT ON NATIONAL/LOCAL BUDGET

The baseline scenario refers to a do-nothing scenario, in which no expansion of the mopeds demo project takes place. As a consequence, the national/local budget remains unaffected by additional revenues or expenditures **directly associated** with the expanded project. The expected effect of the scaled-up project on the national GDP of Vietnam is reported in section 6.17 Impact on national/local budget.

5.10 IMPACT ON EMPLOYMENT

The baseline scenario refers to a do-nothing scenario, in which no expansion of the mopeds demo project takes place. Consequently, it's projected that no jobs directly connected to the realisation of the scaled-up project would be lost. Likewise, any jobs anticipated to be created in direct relation to the expanded project are also not expected to happen. Employment changes that cannot be directly associated with the scaled-up project are deemed out of scope and aren't considered. Thus, in the baseline scenario, no changes in net employment **directly linked** to e-mobility are contemplated, and the total employment change only pertains to changes resulting from the scaled-up project, which is discussed in section 6.18 Impact on employment.

47 https://www.unep.org/resources/toolkits-manuals-and-guides/emob-calculator
48 Microsoft Word - ENG-Vol1-Mitigation-Addressing-CC-Transport-Vietnam-20190913-FINAL-ONLINE.docx (worldbank.org)
49 CO2 emissions from transport (% of total fuel combustion) - Viet Nam | Data (worldbank.org)
50 Vietnam strives to reduce emissions in transportation | NetZero.VN - Net Zero Viet Nam
51 Policy Brief_EN (changing-transport.org)
52 Nitrous oxide emissions (thousand metric tons of CO2 equivalent) - Viet Nam | Data (worldbank.org)
53 Future_air_quality_in_Ha_Noi.pdf (iiasa.ac.at)
54 https://hanoitimes.vn/hanoi-to-expand-public-transport-network-in-period-2021-2030-314585.html
55 Vietnam's road accident-related deaths fall by 43.5% in 2011-2020 | Society | Vietnam+ (VietnamPlus)
56 The Socialist Republic of Vietnam (2020). Approving the National Strategy for ensuring road traffic order and safety for the period 2021-2030 and a vision to 2045. Hanoi, Vietnam
57 Ministry of Transport Viet Nam (2021). VIET NAM ROAD SAFETY STATISTICS AND STRATEGIC GOALS 2021 – 2030. PowerPoint Presentation (unescap.org)
58 Vietnam: number of deaths by traffic accidents 2022 | Statista
59 H. Y. T. Phan, T. Yano, T. Sato, and T. Nishimura, "Characteristics of road traffic noise in Hanoi and Ho Chi Minh City, Vietnam," Applied Acoustics, vol. 71, no. 5, pp. 479–485, May 2010, doi: 10.1016/j.apacoust.2009.11.008.

6 ASSESSMENT OF THE SCALED-UP PROJECT

In this section, a theoretical scaled-up project is assessed against the baseline situation to gauge the impact of the e-moped solution in case it would be rolled out across the region. Section 6.1 describes the boundary conditions of this theoretical scale up.
In accordance with the assessment framework, the expectation was that these assessment results would be loaded into the STAR-rating tool to be able to visually compare the change in KPI's between the baseline and scale up. However, after the assessment was completed, it is deemed better not to use the STAR rating tool for two reasons:

- The differences in KPI values between baseline and scale up are rather small for most KPI's. Translating them to a visual STAR rating would make the difference even less visible.
- While the KPI weighting factors have been validated with the stakeholders, the value functions were not. This was partially due to changes in the stakeholder composition, and partially due to difficulties in getting hold of the stakeholders. Any translation of scores into values would therefore have a weak basis.

6.1 SCALED-UP PROJECT DESIGN

For the purposes of the assessment of the effects in the scaled-up project, the following assumptions were made:

- The scaled-up project consists of an expansion of the demonstration project in which several additional routes are considered instead of simply one route (as in the demo project). A total of 50 routes is assumed for the scaled-up project.
- All routes are assumed to be of the same short distance type as in the demonstration project (i.e., 2.2km).
- For every route, the same number of e-moped vehicles as in the demo project is assumed (i.e., 50 e-mopeds per route, resulting in a total of 2,500 e-mopeds at any given year of the project duration).
- The scaled-up project encompasses the period of 10 years (2020 – 2029).
- It is assumed that all costs associated with running the scaled-up project are to be subsidised by public authorities (e.g., investment in purchasing e-mopeds, operating and maintenance costs, and so on). Similarly, revenues generated by the project over the years are also to be borne by corresponding public authorities.
- It is assumed that all mopeds need to be replaced after five years. Therefore, at the start of the project, 2,500 mopeds are purchased by the public authorities. Midway through the project (year 2025), another 2,500 mopeds are bought, totalling to 5,000 mopeds through the project's lifetime.
- Most of the relevant input factors for financial calculations are derived from the ex-ante financial viability calculations. The input values from the ex-ante calculations refer to cost or revenues for one route and a fleet of 50 e-mopeds. For simplification purposes, these factors are scaled-up to 50 routes (2,500 e-mopeds) whenever relevant.
- It is assumed that with the expansion of the e-mopeds service, the demand for the regular shuttle will reduce by approximately 60%. Therefore, the regular shuttle is expected to run less frequently than in the baseline scenario in which the

scaled-up project does not exist. The scaled-up project is not expected however to completely eliminate the trips by regular shuttle.

- From 3.1, we see 275 rides per 50 e-moped fleet route per day are needed to break even, which equals 5.5 rides per moped per day. Given the scale up, we assume 50 fleets of 50 mopeds, which equals 13,750 rides per day. The total distance, coming from 2.2 km distance per trip, is 30,250 vehicle km per day.
- With the assumption that the average occupancy rate of the shuttle is 10 passengers, 460 passengers are transported per day per route by shuttle, given that the shuttle does 46 rides per day per route. The substitution of moped rides reduces the number of shuttle passengers with 275. These 275 substituted passengers are deducted from the total amount of 460 shuttle passengers, which results in 185 shuttle passengers in an average of 18.5 (10 passengers per shuttle) rides per route. The scale up of 50 routes results in 925 shuttle rides which are still present after the moped substitution, equalling to 2,035 vehicle km per day. This means 1,375 shuttle rides are substituted, and we assume these are removed from the shuttle schedule.

6.2 FINANCIAL VIABILITY

In the ex-ante financial viability (see 3.1) it is shown that to break even at a single site, at the end of the e-moped lifetime 275 trips per day are needed. For the financial viability this number of trips is assumed across all sites (totalling 13,750 per day), but due to investment needed to maintain the fleet for twice the lifetime of the e-mopeds the NPV is negative (-$1,688,061). The IRR is -0.06% and a payback of 5.01 years is found, the latter being calculated per investment round. These numbers are close to 0% and 5 years respectively, the expected numbers for a break even situation. The small difference is due to a rounding error in the number of trips per day, which compounded over the 50 fleets.

6.3 AVAILABILITY OF FINANCIAL RESOURCES

In terms of the availability of financial resources, the same score obtained for the demonstration project is expected to be obtained for the scaled-up version of the project. Therefore, a score of 5 is assigned to the scaled-up project. As mentioned in deliverable D1.6 Impact assessment results Volume 1: Overview, a 5-point scale is used for scoring the availability of financial resources, and this score is directly factored into the evaluation framework.

6.4 COHERENCE WITH NATIONAL PLANS AND DEVELOPMENT GOALS

Regarding the coherence with national plans and development goals, the same score obtained for the demonstration project is expected to be obtained for the scaled-up version of the project. Therefore, a score of 5 is assigned to the scaled-up project. As mentioned in deliverable D1.6 Impact assessment results Volume 1: Overview, a 5-point scale is used for scoring the coherence with national plans and development goals, and this score is directly factored into the evaluation framework.

6.5 ALIGNMENT WITH SUPRA-NATIONAL/NATIONAL/CITY LEGISLATION & REGULATIONS

In terms of the alignment with supra-national/national/city legislation & regulations, the same score obtained for the demonstration project is expected to be obtained for the scaled-up version of the project. Therefore, a score of 2 is assigned to the scaled-up project. As mentioned in deliverable D1.6 Impact assessment results Volume 1: Overview, a 5-point scale is used for scoring the alignment with supra-national/national/city legislation & regulations, and this score is directly factored into the evaluation framework.

6.6 EASE OF IMPLEMENTATION (IN TERMS OF ADMINISTRATIVE BARRIERS)

Regarding the ease of implementation (in terms of administrative barriers), the same score obtained for the demonstration project is expected to be obtained for the scaled-up version of the project. Therefore, a score of 5 is assigned to the scaled-up project. As mentioned in deliverable D1.6 Impact assessment results Volume 1: Overview, a 5-point scale is used for scoring the ease of implementation (in terms of administrative barriers), and this score is directly factored into the evaluation framework.

6.7 IMPACT ON GHG EMISSIONS

The substitution of shuttle rides has a potential decrease in CO2 emissions. In the scale up scenario, the number of passengers moving from shuttle to mopeds is significant and therefore we assume that the amount of shuttle rides is decreased. Due to this substitution, a decrease in actual CO2 can occur. Using the emission data from 6.7, 616 tons of CO2 is saved from a decrease in shuttle rides and substitution by e-mopeds.

Table 11: Avoided CO2 emissions in scale up

	MODE OF TRANSPORT	WTW CO2 VKM[g]	RIDES PER DAY	KM PER DAY	KM PER YEAR	WTW CO2 EMISSIONS [TON]
Regular shuttle service, no mopeds	E-mopeds	8.0	0	0	0	0
	Shuttles	638	2,300	5,060	1,846,900	1,178
	Total	**Sum of e-mopeds and shuttles**				**1,178**
Substitution by mopeds	E-mopeds	8.0	13,750	30,250	11,041,250	88
	Shuttles	638	925	2,035	742,775	474
	Total	**Sum of e-mopeds and shuttles**				**562**
Result	**Total**	**Emissions reduced**				**616**

6.8 IMPACT ON AIR POLLUTANTS

Just as in 6.7, the substitution from shuttle passengers to mopeds results in less air pollutants coming from fossil fuel combustion. Using the emission data from 5.3 the result is that 3.1 tons of NOx is saved and 56.3 kg of PM10 is saved.

g See 1.4.6

Table 12: Avoided NOx emissions in scale up

	MODE OF TRANSPORT	TTW CO2 VKM[h]	RIDES PER DAY	KM PER DAY	KM PER YEAR	WTW CO2 EMISSIONS [TON]
Regular shuttle service, no mopeds	E-mopeds	0	0	0	0	0
	Shuttles	2.82	2,300	5,060	1,846,900	5.2
	Total	**Sum of e-mopeds and shuttles**				**5.2**
Substitution by mopeds	E-mopeds	0	13,750	30,250	11,041,250	0
	Shuttles	2.82	925	2,035	742,775	2.1
	Total	**Sum of e-mopeds and shuttles**				**2.1**
Result	**Total**	**Emissions reduced**				**3.1**

Table 13: Avoided PM10 emissions in scale up

	MODE OF TRANSPORT	TTW CO2 VKM[i]	RIDES PER DAY	KM PER DAY	KM PER YEAR	WTW CO2 EMISSIONS [KG]
Regular shuttle service, no mopeds	E-mopeds	0	0	0	0	0
	Shuttles	0.051	2,300	5,060	1,846,900	94.2
	Total	**Sum of e-mopeds and shuttles**				**94.2**
Substitution by mopeds	E-mopeds	0	13.750	30,250	11,041,250	37.9
	Shuttles	0.051	925	2,035	742,775	0
	Total	**Sum of e-mopeds and shuttles**				**37.9**
Result	**Total**	**Emissions reduced**				**56.3**

6.9 IMPACT ON ACCESSIBILITY

Similarly to the ex-ante assessment of this KPI (section 3.8), no effect is expected on the accessibility as the e-mopeds use existing bus stops for their rental stations, so the network coverage is expected to stay the same.

6.10 AFFORDABILITY OF E-VEHICLE SERVICES

Similar to the ex-ante situation (section 3.9) the affordability is not expected to change in favour of the traveller. The cost will either be the same to travellers, or will be higher in case it is not fully subsidized by a third party, as it is being done by the mall for the shuttles.

6.11 IMPACT ON TRAVEL TIME

Given that the scale up is a simple multiplication of the ex-ante situation from 1 to 50 fleets, the impact on travel time is expected to be similar to the ex-ante case (section 3.10), i.e. a 29% decrease or about 6 minutes on average for each site. It should be noted this is sensitive to the shuttle schedule at each site in the baseline situation, which is expected to vary when there are 50 sites.

h See 1.4.6
i See 1.4.6

6.12 IMPACT ON ROAD SAFETY

Given the relatively high number of accidents with two-wheelers in Vietnam, it is likely that traffic safety will decrease with an increase in two-wheeler km's (see also 6.12). The scale up includes 13,750 moped rides per year equalling to over 11 Million km (see Table 11). Given the relatively high average fatality and injury rate in Vietnam (see 5.6 and Table 9), several incidents resulting in injury can be expected. Table 9 presents average fatality and injury data. Taking these numbers, and given the 11 Million km's by the mopeds, between 0.2 and 0.6 expected fatalities and between 0.4 and 8.5 injuries could occur due to traffic accidents with these mopeds.

6.13 IMPACT ON CHARGING SAFETY

A larger fleet of mopeds require more batteries to be charged. The scale up assumes 50 routes, which could require a maximum of 50 charging facilities. Battery swapping could also be a possibility, distributing batteries from several larger charging facilities. As discussed in 3.12, risk on charging safety is complex to answer, also for the scale up. Given the increased number of batteries that need to be charged, the risk of accidents occurring could become higher, also given the lack of safety standards specifically towards electric two-wheelers. Though the services provided by the supplier and the overall electric vehicle decrees indicate that safety precautions will be taken, also taking the large number of batteries in question.

6.14 IMPACT ON SECURITY

For the impact on security, the same indicator evaluated for the ex-ante assessment (annual number of theft incidents) is reported, but now considering the scaled-up project. From the ex-ante input data and calculations, the percentage of motorcycles stolen (as share of the motorcycle stock) is expected to be of 0.08% of the total motorcycle stock. The following baseline and scaled-up project scenarios can be then derived.

Table 14 Expected number of motorcycles stolen per year (Baseline and scaled-up project scenarios)

SCENARIO	NUMBER OF REGISTERED MOTORCYCLES[1] [A]	% MOTORCYCLES STOLEN (AS SHARE OF MOTORCYCLE STOCK) [B]	EXPECTED NUMBER OF MOTORCYCLES STOLEN PER YEAR [C] = [A] X [B]
Baseline			
2020	72,061,323	0.08%	57,649
2021	75,375,437		60,300
2022	78,841,967		63,074
2023	82,467,923		65,974
2024	86,260,638		69,009
2025	90,227,781		72,182
2026	94,377,373		75,502
2027	98,717,806		78,974
2028	103,257,856		82,606
2029	108,006,704		86,405
Total 2020 - 2029			711,676

Baseline			
2020	72,063,823		57,651
2021	75,378,052		60,302
2022	78,844,702		63,076
2023	82,470,784		65,977
2024	86,263,631	0.08%	69,011
2025	90,233,411		72,187
2026	94,383,263		75,507
2027	98,723,966		78,979
2028	103,264,300		82,611
2029	108,013,444		86,411
Total 2020 - 2029			711,712
Δ Totals (Scaled up project - Baseline)			36

NOTES	
[1]	Baseline scenario: the number of registered motorcycles was computed based on data from from ASEANstats [1A] using the following steps: • For 2020 the data was used as provided by ASEANstats • For 2021 onwards, the motorcycle stock of the previous year was used together with a calculated yearly grow of the motorcycle stock. The yearly growth rate was obtained from historical data provided by ASEANstats by calculating the average annual increase in the number of motorcycles divided by the motorcycle stock of 2020 resulting in an yearly increase reate of 5.41%. Scaled-up project: the procedure used was similar to the baseline scenario: • For 2020 the data was used as provided by ASEANstats + 2500 mopeds (1st acquisition). • For 2021 - 2024 the motorcycle stock of the previous year was used together with a calculated yearly grow of the motorcycle stock of 5.41% • For 2025 the motorcycle stock of 2024 was used together with a calculated yearly grow of the motorcycle stock of 5.41% + 2500 mopeds (2nd acquisition) • For 20216- 2029 the motorcycle stock of the previous year was used together with a calculated yearly grow of the motorcycle stock of 5.41%

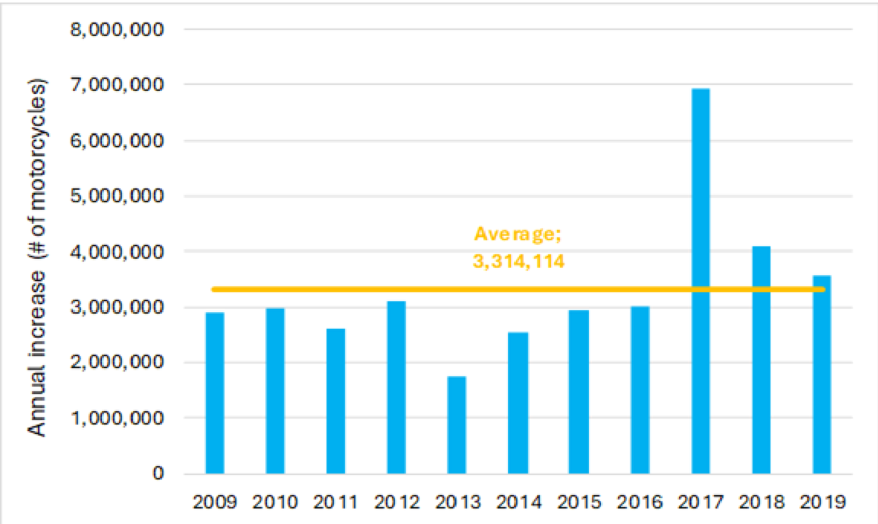

Figure 28: Projection of traffic fatalities, based on Vietnam traffic safety goals

6.15 IMPACT ON NOISE

While in the ex-post assessment (section 4.1) the subjective measures show that the noise level is "5. significantly quieter", the literature from the baseline scenario59 suggests that horn noise is a strong contributor to experienced traffic noise. As in this scaled up project design a single shuttle (with a single horn) is replaced by multiple e-mopeds (with each a single horn) the possibility exists that this leads to more traffic noise.

6.16 QUALITY OF E-MOBILITY SERVICES

Expectation is that the scaled up project has no influence on the experienced quality of e-mobility services w.r.t. to the ex-post assessment, therefore similar numbers as in the ex-post assessment are expected (see section 4.2).

6.17 IMPACT ON NATIONAL/LOCAL BUDGET

As mentioned in section Scaled-up project design, it is assumed that all costs associated with running the scaled-up project are to be subsidised by public authorities (e.g., investment in purchasing e-mopeds, operating and maintenance costs, and so on). Similarly, revenues generated by the project over the years will benefit the corresponding public authorities. The baseline scenario, in turn, refers to a do-nothing scenario, in which no expansion of the mopeds demo project takes place and, consequently, the national/local budget remains unaffected by any additional revenue or expenditure that would have been associated with the expanded project. The expected effects on the local budget are provided below. As the net present value of the scaled-up project is negative (-$1,688,060.79), this means that the scaled-up project is not fully viable by itself from a financial perspective and that an amount of around US$ 1.69 million would have to be allocated to the project (in 2020 monetary terms) for the project to break-even in terms of profitability. Assuming that the public authorities from Vietnam would allocate such an amount to achieve a break-even point, one can calculate what would be the effect of that on the national budget. As the economic data for Vietnam from the World Bank expresses the country's GDP in constant 2015 US$, the obtained NPV value was expressed in 2015 US$ and used to compute the share of the national budget (expressed in 2015 US$) that the NPV of the scaled-up project would comprise.

Table 15 Impact of the scaled-up project on national budget

Discount rate	10%

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Investment	$ -5,005,000						$-5,005,000				
Purchased fleets	50						50				
Mopeds per fleet	50						50				
Purchased mopeds	2500						2500				
Obsolete fleets						50 [A]					50 [A]
Active fleets		50	50	50	50	50	50	50	50	50	50
Annual revenues		$ 5,253,936	$ 5,253,936	$ 5,253,936	$ 5,253,936	$ 5,253,936	$ 5,253,936	$ 5,253,936	$ 5,253,936	$ 5,253,936	$ 5,253,936
Annual operating & maintenance costs		$ -4,254,333	$-4,254,333	$ -4,254,333	$ -4,254,333	$-4,254,333	$-4,254,333	$-4,254,333	$-4,254,333	$ -4,254,333	$-4,254,333
Net pre-tax cash flow	$ -5,005,000	$ 999,604	$ 999,604	$ 999,604	$ 999,604	$ 999,604	$-4,005,396	$ 999,604	$ 999,604	$ 999,604	$ 999,604

Net present value [C]	-$1,688,060.79

Notes:	
[A]	After five years the mopeds reach the end of their usable life and become obsolete

Economic data Vietnam (source: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?end=2022&locations=VN&start=2012)

GDP Vietnam	2015	$ 239,260,000,000.00	Inflation rate	2015	-
	2016	$ 255,260,000,000.00		2016	0.067
	2017	$ 272,980,000,000.00		2017	0.069
	2018	$ 293,360,000,000.00		2018	0.075
	2019	$ 314,950,000,000.00		2019	0.074
	2020	$ 323,970,000,000.00		2020	0.029
				Cumulative 2015-2020 [C]	1.354

Net present value (in 2015 US$) [D] = [B] x [C]	-$2,285,718.69
NPV as share of 2020 GDP (in 2015 US$)	0.00071%

6.18 IMPACT ON EMPLOYMENT

For the analysis of the impact on employment, the absolute number of net additional jobs (NNET = NADD – NLOST) expected to be generated by the scaled-up project in comparison to the baseline scenario is reported. The expected number of jobs created by the scaled-up project is assumed to be equal to the number of jobs created for the demo project but scaled-up to consider a much higher number of e-mopeds. For the demo project, it was estimated the need for 10 employees, as reported in Table 6, for one fleet (i.e., 50 e-mopeds). Since the scaled-up project consist of 50 fleets (i.e., 2.500 e-mopeds at any given year during the project duration), it is considered that 500 jobs would be created as a result of the scaled-up project (i.e., NADD = 500). This number of jobs created take into account only jobs related to the operation of the scaled-up project, and not jobs related to the manufacturing of e-mopeds, as this might not necessarily happen locally.

As mentioned in the section Scaled-up project design (see 6.1), it is expected that the scaled-up project will lead to a reduction (but not elimination) of the demand for the regular shuttle, making it run less frequently than in the baseline scenario in which the scaled-up project does not exist. The timetable provided in Figure 16 was used to estimate this impact. Based on the time between the last trip is expected to return to BRT and the time of the first trip departure from BRT, an operating period of around 11h was estimated, resulting in a total of 46 rides per day per shuttle bus (i.e., 23 rides BRT – Mall and 23 rides Mall – BRT). Given that an operating period of 11h represents almost half a day, it was estimated that two bus drivers would be necessary to provide this service level (each taking roughly half the operating time).

Considering that the substitution of moped rides (275) results in 185 shuttle passengers and in an average of 18.5 rides per day (as mentioned in section 6.1 Scaled-up project design), this represents a reduction of around 60% in the number of daily rides (from 46 to 18.5). With 18 rides per day (i.e., 9 rides BRT – Mall and 9 rides Mall – BRT), it is estimated that the average time between departures (BRT – Mall) would be of 01h21min (instead of 29min for the current situation), in case of the same operating window of around 11h. These numbers were obtained by analysing (based on the timetable provided in Figure 16) how many shuttles leave the BRT between 10:00 – 13:59, 14:00 – 17:59, and 18:00 – 21:59. The number of trips were then adjusted for the scaled-up scenario (in which there are 9 departures from the BRT instead of 23) trying to maintain the same proportion of trips within the above mentioned time periods. In the original scenario, 7 trips leave the BRT between 10:00 – 13:59 (3 estimated for the scaled-up scenario), 9 trips leave the BRT between 14:00 – 17:59 (4 estimated for the scaled-up scenario), and 7 trips leave the BRT between 18:00 – 21:59 (2 estimated for the scaled-up scenario). Table 16 and Table 17 present the detailed analysis regarding number of drivers and operating time for the baseline and scaled-up scenarios.

Given the expected reduction in the demand for these types of shuttle buses due to the expansion of the e-mopeds, it is assumed that it won't be necessary to have two drivers anymore per shuttle per day, but only one. Even though it was considered that the hours of operation would remain of around 11h, the average rest of this single driver would be significantly superior to the case with no shuttle trip reduction (01h06min versus around 14min). For this reason, it was considered that one driver would be able to perform this operation instead of two. Considering that 50 routes (assumed to be of the same short distance type as in the demonstration project) have been considered for the scaled-up project, it is expected that the scaled-up project will lead to the loss of 50 jobs (i.e., NLOST = 50).

Finally, since the baseline scenario refers to a do-nothing scenario, in which no expansion of the mopeds demo project takes place, it can be estimated that none of the 50 jobs directly related to mobility are expected to be lost. A similar argument can be made regarding the jobs created in which the 500 jobs expected to be created directly related to e-mobility are no longer generated. Therefore, in the baseline scenario, no changes in net employment **directly related** to e-mobility are considered, and the total change in employment becomes:

Table 16 Analysis of operating time and number of drivers needed per shuttle route (baseline scenario)

- $N_{NET} = N_{ADD} – N_{LOST} = N_{ADD\ (SCALED\text{-}UP\ PROJECT)} – N_{LOST\ (SCALED\text{-}UP\ PROJECT)}$ = 500 – 50 = 450.

Table 16 Analysis of operating time and number of drivers needed per shuttle route (baseline scenario)

Avg time between trips	Time between trips [I]	Leave BRT [A]	Trip [B]	Arrive at Mall [C]	Wait at mall [D]	Depart mall [E]	Arrive back at BRT [F]	Theoretical rest time [G]	Average rest time [H]	Shuttle driver
00:29	-	10:10	00:05	10:15	00:05	10:20	10:25	00:35	00:16	Driver 1
	00:50	11:00	00:05	11:05	00:05	11:10	11:15	00:10		
	00:25	11:25	00:05	11:30	00:05	11:35	11:40	00:10		
	00:25	11:50	00:05	11:55	00:05	12:00	12:05	01:00		
	01:15	13:05	00:05	13:10	00:05	13:15	13:20	00:10		
	00:25	13:30	00:05	13:35	00:05	13:40	13:45	00:10		
	00:25	13:55	00:05	14:00	00:05	14:05	14:10	00:10		
	00:25	14:20	00:05	14:25	00:05	14:30	14:35	00:10		
	00:25	14:45	00:05	14:50	00:05	14:55	15:00	00:10		
	00:25	15:10	00:05	15:15	00:05	15:20	15:25	00:10		
	00:25	15:35	00:05	15:40	00:05	15:45	15:50	00:10		
	00:25	16:00	00:05	16:05	00:05	16:10	16:15	00:10	00:12	Driver 2
	00:25	16:25	00:05	16:30	00:05	16:35	16:40	00:10		
	00:25	16:50	00:05	16:55	00:05	17:00	17:05	00:10		
	00:25	17:15	00:05	17:20	00:05	17:25	17:30	00:10		
	00:25	17:40	00:05	17:45	00:05	17:50	17:55	00:55		
	01:10	18:50	00:05	18:55	00:05	19:00	19:05	00:10		
	00:25	19:15	00:05	19:20	00:05	19:25	19:30	00:05		
	00:20	19:35	00:05	19:40	00:05	19:45	19:50	00:10		
	00:25	20:00	00:05	20:05	00:05	20:10	20:15	00:00		
	00:15	20:15	00:05	20:20	00:05	20:25	20:30	00:10		
	00:25	20:40	00:05	20:45	00:05	20:50	20:55	00:05		
	00:20	21:00	00:05	21:05	00:05	21:10	21:15			

Number of trips in day [J]	23
Hours of operation [K]	11:05
Hours of operation driver 1 [L]	05:40
Hours of operation driver 2 [M]	05:15

Notes

[A]	Departure times taken from shuttle timetable provided in Figure 1.15
[B]	Considering a 5min trip between BRT and Mall
[D]	Considering a 5min wait time at mall
[F]	Considering a 5min trip between Mall and BRT
[G]	= [A] - [F]
[H]	Considers average of theoretical rest time per driver
[I]	Considers time between consecutive departures from BRT
[J]	= COUNT ([A])
[K]	= Time last arrival back at BRT - Time first departure BRT
[L]	Considers only working hours for driver 1
[M]	Considers only working hours for driver 2

Table 17 Analysis of operating time and number of drivers needed per shuttle route (scaled-up scenario)

Avg time between trips	Time between trips [I]	Leave BRT [A]	Trip [B]	Arrive at Mall [C]	Wait at mall [D]	Depart mall [E]	Arrive back at BRT [F]	Theoretical rest time [G]	Average rest time [H]	Shuttle driver
01:21	-	10:10	00:05	10:15	00:05	10:20	10:25	01:00	01:06	Driver 1
	01:15	11:25	00:05	11:30	00:05	11:35	11:40	01:50		
	02:05	13:30	00:05	13:35	00:05	13:40	13:45	00:35		
	00:50	14:20	00:05	14:25	00:05	14:30	14:35	00:35		
	00:50	15:10	00:05	15:15	00:05	15:20	15:25	01:00		
	01:15	16:25	00:05	16:30	00:05	16:35	16:40	01:00		
	01:15	17:40	00:05	17:45	00:05	17:50	17:55	01:40		
	01:55	19:35	00:05	19:40	00:05	19:45	19:50	01:10		
	01:25	21:00	00:05	21:05	00:05	21:10	21:15			

Number of trips in day [J]	9
Hours of operation [K]	11:05
Hours of operation driver 1 [L]	11:05

Notes

[A]	Departure times taken from shuttle timetable provided in Figure 1.15
[B]	Considering a 5min trip between BRT and Mall
[D]	Considering a 5min wait time at mall
[F]	Considering a 5min trip between Mall and BRT
[G]	= [A] - [F]
[H]	Considers average of theoretical rest time per driver
[I]	Considers time between consecutive departures from BRT
[J]	= COUNT ([A])
[K]	= Time last arrival back at BRT - Time first departure BRT
[L]	Considers only working hours for driver 1
[M]	Considers only working hours for driver 2

7 DISCUSSION

7.1 FINDINGS

7.1.1 Effect on project finances

The explorative analysis in the ex-ante assessment focussed on the break even point as an indicator for **financial viability**. It showed that to break even at the end of the e-moped lifetime 275 daily trips are required per fleet of 50 vehicles. Given the popularity of the route and the large operational time window this should be achievable, given that there is not a more favourable transport option available to travellers.

Regarding the **availability of financial resources**, as addressed in section 3.2 Availability of financial resources, it appears that funding can be available for scaled-up e-mopeds project. This conclusion is supported by both public authorities and private sources. On the public side, decision No. 882/QD-TTg approving the National Action Plan on Green Growth for the period 2021-2030 addresses the mobilisation of financial resources and the promotion of investments for green growth. Furthermore, on the private side, there are examples of market interest from the letter of interest from the United States International Development Finance Corporation to Vinfast for the establishment of lithium-ion battery manufacturing facilities in Vietnam, and from the cooperative agreement with VinFast and the Cake by VPBank digital bank to encourage the migration from gasoline to electric vehicles in Vietnam. As mentioned previously in this report, the net present value of the scaled-up project is negative. This implies that, purely from a financial perspective, the project isn't self-sustaining and would require external funding. However, given the mentioned examples of financial interest coming from public authorities and private parties, as well as the market share that motorcycles have in the transport modes in Vietnam, it is reasonable to expect that there would be financial resources available to make such a scaled-up version of the project possible.

7.1.2 Institutional framework

The institutional framework aspect is covered by the assessment of the level 2 indicators **coherence with national plans and development goals, alignment with supra-national/national/city legislation & regulations, and ease of implementation (considering administrative barriers)**. For all of these components, the only one in which some uncertainty was experienced was the alignment with policies and regulations. The reason for it is that, although multiple examples of policies and legislations related to the e-mopeds project were identified (e.g., the masterplan on the road network for the 2021-2030, the Green Energy Transition Action Program, the National Energy Masterplan, the National Environmental Protection Strategy to 2030, among others), the available information is not sufficient to fully ascertain whether the proposed project is fully compliant with all relevant legislations. These policies and legislations provide a long-term goal or vision regarding energy, environment or transportation, outlining what is required, what changes will occur, and the timeline for these changes, without necessarily detailing how these regulations or policies will be implemented.

An important remark worth noting is that many of the above mentioned policies and legislations do not explicitly refer to electric motorcycles (or similar terms). Instead, they often use broader terms (e.g., electric road vehicles) or specifically refer to cars (e.g., battery electric cars). While it is reasonable to assume that electric motorcycles fall under the umbrella of electric vehicles whenever addressed in policies and legislations, if this proves not to be the case, then additional barriers might arise in the development of scaled-up projects such as the one assessed in this report. Another important remark refers to the fact that there are ongoing discussions regarding a proposed ban on motorbikes within Hanoi's inner city by 203[60]. Identified references to this potential ban only mention "motorcycles", without specific possible differentiation for electric motorcycles. Should this ban materialise, it could jeopardise the feasibility of electric moped projects such as the one assessed in this report.

7.1.3 Effect on climate

The use of e-mopeds results in a theoretical reduction in monthly average CO2 **(greenhouse gas (GHG))** emissions of 32 kg WTW. The total pilot has a theoretical CO2 reduction of 193 kg WTW. This theoretical reduction in GHG emissions comes from passengers switch from taking the shuttle bus to the e-mopeds. When there is an actual reduction in shuttle km, only then there is a substitution of vehicle km and actual reduction of GHG emissions. Since there is no indication of a reduction in shuttle rides or kilometres. The scale up (50 routes) takes into account that there is a passenger km substitution which results in 616 tons of CO2 reduction WTW.

7.1.4 Effect on environment:

Following the reasoning of theoretical and actual substitution of vehicle km in 7.1.4, the pilot results in a theoretical reduction in **air pollutants** 3.1 tons NOx and 56.3 Kg PM_{10}. The scale up (50 routes) results in a substitution of vehicle km and results in a reduction of 3.1 tons of NOx and 56.3 kg of PM10.

7.1.5 Effect on society

According to sources stated in 3.11, a shift from two-wheelers to public transport on the road results in higher **traffic safety**. Given that the pilot results in more two-wheeler kms, and also overall vehicle kms given that the shuttle is assumed to be driving its regular service, results in lower traffic safety. The effect is expected to be minor, given the relatively low amount of kms driven by the e-mopeds in the pilot. The scale up assumes a lot more two-wheeler kms, and although there is a substitution of vehicle kms, will result in lower traffic safety.

The effect on **charging safety** is undefined. There are some imaginable risks, but Vinfast offers the installation of the charging and battery swap systems. Although specific guidelines are missing for electric two-wheelers, electric car guidelines about charging systems are in place.

The **accessibility** improvement for society is expected to be minimal as the e-mopeds must travel between stations, which are placed at existing boarding locations for the shuttle. The network is therefore not extended. However, as the e-moped fleet is assumed to be large enough to accommodate travellers immediately, the **travel time** is expected to decrease due to the lack of waiting time.

On the **affordability** side the effects are partially unknown as the pilot offered the e-mopeds free of charge and the Mall subsidizes the current shuttles. If the subsidy is applied to the e-mopeds at the different sites the affordability for the traveller will stay the same at best, but is not expected to improve as the shuttles are already free.

The **effect on security** was evaluated using the estimated annual number of motorbike theft incidents. There was no reliable source with available data directly from Vietnam, so benchmarks from neighbouring countries (Laos an Thailand) as well as other countries (the Netherlands and the United States) were used for comparison. Based on these benchmarks, a proxy for Vietnam's motorcycle theft rate (as a percentage of motorcycle stock) was calculated.

Given that the total number of e-mopeds involved in the scaled-up project (5,000) is minimal in comparison to Vietnam's total stock of motorcycles (estimated to be around 72 million by 2020), only a few dozen additional motorcycles are expected to be stolen as a result of the scaled-up project. Due to a lack of specific data, it was estimated that e-mopeds and conventional motorcycles share the same percentage of motorcycle theft (as a share of motorcycle stock) of 0.08%. However, it is reasonable to expect that e-mopeds might get stolen more frequently than conventional motorcycles if stolen electric motorcycles can be sold or disassembled for parts at a higher profit than conventional ones.

The **service quality** is rated by the survey respondents on a set of topics with respect to the old situation where no e-mopeds are available and they had to take the shuttle or walk. Overall the perceived comfort, ease of use while driving and renting, and the continuity of the journey chain was rated positively with scores close to the maximum of 5. However, the weather suitability was rated lower at 3.2, presumably as e-mopeds don't provide any cover when it rains. The perceived safety score of 3.9 is on the lower side, compared to the other perceptions measured in the survey but still positive.

7.1.6 Effect on wider economy

The effect on the wider economy aspect is covered by the assessment of the level 2 indicators **effect on national budget** and **effect on employment**. Regarding the impact on the national budget, as mentioned previously in this report, the net present value of the scaled-up project is negative. This implies that, purely from a financial perspective, the project isn't self-sustaining and would require external funding of around US$ 1.69 million (in 2020 monetary terms) for the project to break-even in terms of profitability. If public authorities from Vietnam were to finance all this amount in order to reach break-even point, the expected impact on national budget (as share of GDP) is of circa 0.00071%. Considering that the effect on society (weight of 31.77), effect on environment (16.20), and effect on institutional framework (15.38) all received higher priority than the effect on project finances (13.78), public authorities might opt to fund the assessed scaled-up project due to its expected impact on these other areas.

Regarding the **effect on employment**, the scaled-up project is expected to generate a job surplus of 450 jobs when accounting also for the effect of potential job losses in conventional shuttle services (affected by a larger-scale introduction of e-mopeds). Although the overall effect on employment is positive, when compared against Vietnam's total labour force (estimated at approximately 55.7 million people in 2022[61]), the projected impact remains marginal.

7.2 RECOMMENDATIONS

For future work on the implementation of e-mopeds in Hanoi the authors would like to make a few recommendations, both on implementation and on the assessment of the process.

The nature of e-mopeds, especially in the current demo implementation is rather local: shuttle routes of a few km's are being targeted, with travel times of a few minutes. However, the current assessment has a very wide scope that targets changes on a national level. While this is understandable from a policy point of view, the effect becomes rather negligible when looking at that level. The effect on a local level could be very pronounced, but when zooming out to the level of a city or a country the effects are diluted. The recommendation is to steer future assessments towards a local approach (on neighbourhood or district level) where each shuttle route is assessed separately, as small changes in the shuttle route can have an impact on the effectiveness of the e-moped service. Lastly, on the assessment process, the collaboration for an European knowledge institute with local stakeholders proved difficult due to differences in approach and physical distance. The recommendation is to give a local knowledge institute a prominent, leading role in such an assessment as they are better aware of local processes and know how to approach stakeholders effectively. External institutes (from other countries) could be involved, but perhaps only for a few consulting and knowledge exchange sessions.

This point of sensibility should also be taken into account when building further on the current assessment. Most KPI calculations are very sensitive to the initial assumptions. While those assumptions are valid for the demo pilot site, it is hard to validate them when scaling up to many different sites. It is recommended to approach each site separately in a future assessment, or apply certain categorization such that assumptions can be used for similar sites.

On the implementation itself the recommendation is to investigate if e-mopeds can replace other modes of transport than the shuttle. By focussing on shuttles, which are a relatively safe mode of transport, the improvement is less pronounced as the reduction in safety offsets the reductions in emissions. If however, ICE mopeds would be targeted for replacement by e-mopeds, the reduced emissions are not offset and the net gain is higher. Finally, the roll-out proved to be challenging due to issues in finding a partner for setting up the IoT devices on the mopeds such that users could rent them via an app. Before further roll-out the focus should be shifted towards getting one site properly operational and user friendly before replication to other sites.

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60 https://tuoitrenews.vn/news/society/20230615/hanoi-persists-in-banning-motorbikes-from-inner-city-by-2030/73821.html#:~:text=The%20People%27s%20Committee%20of%20Hanoi,by%202030%20despite%20public%20concerns.

61 https://data.worldbank.org/indicator/SL.TLF.TOTL.IN?locations=VN